

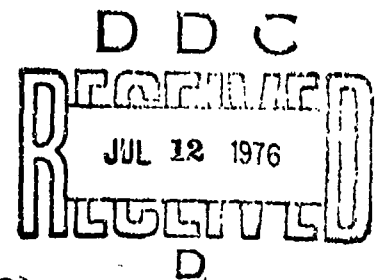
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INVESTIGATION  
OF  
PIPELINE CONCEPTS, MATERIALS AND  
CONSTRUCTION TECHNIQUES

INTERIM REPORT  
JANUARY 1976 - MAY 1976

Approved for Public Release, Distribution Unlimited

Prepared For  
U. S. Army Mobility Equipment  
Research and Development Command  
Fort Belvoir, Virginia 22060



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configuration; (2) Defining interrelationships between those factors; (3) Researching and describing alternative pipeline concepts; (4) Selecting candidate concepts exhibiting greatest potential. Methodology for evaluating performance of system concepts is developed. Design criteria are discussed. State-of-the-art and older systems are compared.

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## PREFACE

This Interim Report describes Phase I work authorized by the United States Army Mobility Equipment Research and Development Command, Fort Belvoir, Virginia, under contract DAAG53-76-C-0096.

The work detailed herein comprises the definition and preliminary evaluation portions of the investigation of pipeline concepts, materials, and construction techniques. Phase II will involve a more thorough investigation of those pipeline concepts offering the greatest potential for military application.

The results of the investigation and the accompanying recommendations concerning pipeline construction techniques will ultimately be combined with studies on other aspects of the military pipeline design problem to form part of the background research and development material for revised military planning.

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# LIST OF SYMBOLS

Symbol	Abbreviation in Charts (Figures 1, 5, and 6)
AT	Air Transport
BF	Bends vs Fittings
CL	Climate
DI	Diameter
EI	Equipment Reqd (Installation)
ET	Equipment Reqd (Transportation)
FF	Friction Factor
FT	Fluid Temperature
HD	Hostility Duration
IR	Installation Rate
IT	Inspection/Test
JC	Joint Cleanliness
JM	Joining Method
MA	Material
MI	Manhandling (Installation)
MN	Maintainability
MT	Manhandling (Transportation)
NC	Number of Crews
NL	No Parallel Lines
NP	No of Pump Station
PC	Product Contam
PF	Pre-fab Capability
PH	Pump Horsepower
PL	Pressure Loss
RC	Reuse Components
RL	Reliability
RW	Right of Way Reqd
SB	Surface vs Buried
SC	Size of Crews
SE	Service Life
SF	Safety
SK	Skill Level
SL	Section Length
ST	Storage Life
TJ	Time per Joint
TL	Total Length
TN	Terrain
TP	Throughput
VE	Velocity
VL	Vulnerability
WE	Weight
WP	Working Pressure
WT	Wall Thickness

## INTRODUCTION

Military land transportation and distribution of bulk petroleum products under wartime conditions present complex and demanding engineering criteria for the design of a pipeline system. It is the Army's obligation to meet the numerous requirements imposed in installation and operation. To that end, the purpose of this study is to examine alternative pipeline concepts, and to select those candidates whose material properties, joining methods, and construction techniques most closely meet the following objectives:

1. Maximum system reliability
2. Maximum rate of construction
3. Minimum crew numbers, sizes, and skill levels
4. Minimum total amount of equipment required
5. Minimum total life cycle cost for a complete pipeline system
6. Minimum fuel loss potential
7. Minimum repair and maintenance time

The pipeline concepts selected as a result of the work during Phase I of the investigation will be the subject of a more intensive examination during Phase II, in order to establish a detailed measure of cost and performance for those concepts.

## INVESTIGATION

### Background and Scope

The bulk fuel supply concept using military pipeline systems has proven to be an effective means for transporting large quantities of liquid hydrocarbon fuels. Nevertheless, the use of coupled pipelines presents various problems with regard to material composition, installation, environment, and other considerations.

Welded steel pipelines currently dominate the industry, yet the welding process requires perfection to assure reliable construction. To date, the Army has been unable to develop and maintain adequate crews of qualified welders to support tactical military operations.

Early development of an automatic pipeline welding machine for use by the Army made little progress. The mobile pipe mill developed by industry in the early 1960's showed promise, but its operation was beset by problems with production rate, reliability, operability, maintainability, maneuverability, transportability, and safety. MERADCOM subsequently recommended termination of the mobile pipe mill development task. Both ideas have since undergone commercial development, but are not the ultimate systems.

The search for a more effective bulk petroleum distribution system, however, has led to use of alternative materials for construction. A Combat Operations Research Group (CORG) study concluded that conventional steel pipe be replaced with buckle-jointed aluminum pipelines. A feasibility study conducted for MERADCOM by Picatinny Arsenal suggested field fabrication of fiberglass reinforced plastic (FRP) pipe as a potential means of military pipeline construction. However, considering only the high throughput requirement and the rate of pipeline construction required for mobile military operation

an effective method of pipeline construction has yet to be determined.

The investigation of various pipeline concepts, materials, and construction techniques suitable for the military under stringent conditions, involves numerous considerations. The scope of the present study necessarily cannot cover all materials, joining techniques, and construction procedures, but did involve a wide range of pipeline designs incorporating accepted industry application criteria. Particular attention was given to various materials used to fabricate the pipeline including metals, plastics, composites and elastomers. Consideration also was given to operation and maintenance levels, personnel required for installation, system reliability and cost.

Phase I of the investigation was, in effect, a four-part study to reduce the large number of possible pipeline concepts to a smaller number of the most promising ideas designated for further analysis. The first part consisted of defining the factors and characteristics to be considered and constraints to be applied in determining the concepts' technical feasibility and military suitability. The next part consisted of establishing the interrelationships between the factors, characteristics, and constraints. The third part involved developing a comprehensive listing of alternative pipeline concepts. The final part of the study was the evaluation of all concepts identified and selection of those pipeline concepts offering the greatest potential for use in a military bulk fuel distribution system environment.

Phase II of the investigation will be the more detailed study of those selected concepts.



## Industry Survey

A considerable portion of Phase I effort involved acquisition of data pertaining to pipeline material, installation, and construction techniques. This was necessary to be able to subsequently define the pipeline concepts.

At the outset, 14 companies cited in CORC's Bulk Petroleum Facilities and Systems (BPFS) Report (Reference 1), were contacted so as to update as much as possible the report findings. Appendix B contains a listing of those companies. In addition, manufacturers and suppliers listed in industrial directories under appropriate "pipe" headings were contacted. Of the 774 companies contacted (Appendices B and C), 264 replied, Sixty-seven supplied useful information, and 29 supplied information that was used in the concepts.

Other sources of information consisted of professional and trade organizations, listed in Appendix D, some of whom also furnished membership lists.

## Design Constraints and System Characteristics

The factors affecting the design of military pipeline systems were classified as external design constraints and pipeline system characteristics. The external constraints were those factors pertaining more to external physical limitations of the pipeline than the inherent system characteristics. The pipeline's "total length" and "throughput" are examples of external constraints, whereas "pressure loss" is a system characteristic. The factors are listed and defined on the following pages under six major groupings: (1) external constraints, (2) storage, (3) transportation, (4) installation, (5) operation, and (6) pipe physicals. The list represents those parameters considered primary to the pipeline system. It was not intended to be all-inclusive, but rather to reflect professional judgement as to the most significant items.

### ° External Constraints

Total Length - The total required length in miles of completed pipeline measured from the point of entry to the bulk distribution breakdown point.

Throughput - The daily maximum required quantity of fuel to be passed through the pipeline within 22 hours.

Installation Rate - The speed at which pipeline must be installed (miles/day).

Climate - The climatic conditions at the installation location which affect pipeline installation and operation.

Terrain - The surface features of the installation location which affect pipeline installation and operation.

Hostility Duration - The time span of the wartime conditions under which the pipeline must operate

° Storage

Storage Life - The maximum period of time materials may be stored under probable (storage) conditions without deterioration.

° Transportation

Air Transport - The degree of suitability for air transportation via C-130 aircraft.

Manhandling - The degree of suitability of pipeline components for repeated physical handling by personnel; the maximum allowable weight of materials per man is assumed to be 30 pounds for repeated lifting.

Equipment Required - The types and quantities of equipment required for delivery of pipeline components to the installation site.

° Installation

Number of Crews - The total quantity of crew units required to install the pipeline at the specified installation rate.

Size of Crews - The number of persons required on each installation (joining) crew to meet the specified installation rate with the method employed.

Skill Level - The level of training and practical experience required of each crew member for proper installation of the pipeline.

Safety - The absence or presence of hazards (to personnel) inherent in a particular construction technique.

Equipment required - The types and quantities of equipment required for installation and construction of the pipeline.

Surface vs Buried - The relation with regard to advantage of installed pipeline (below ground) to pipeline installed at ground level.

Joining Method - The construction techniques and mechanical components required to join pipe sections during installation.

Time per Joint - The average elapsed time required by personnel to join two pipe sections during installation and move to the next joint.

Joint Cleanliness - The level of foreign matter present during installation which affects proper joining of pipe sections.

Manhandling - The degree of suitability of pipeline components for physical handling by personnel; the maximum allowable weight of materials per man is assumed to be 30 pounds for repeated lifting.

Reuse components - Those pipeline system components which are capable of being reused in new construction.

Pre-Fab Capability - The possibility of performing some assembly operations prior to stringing the pipe, such as attaching a coupling to one end of each length of pipe, so that only one connection need be made at installation.

Bends vs Fittings - The relation with regard to advantage of the use of bent pipe sections as opposed to the use of separate fittings for directional changes in the pipeline.

Right-of-Way Required - The distance (measured in feet) required on either side of the pipeline for equipment and personnel during installation.

Inspection/Test - The inspection and testing requirements for all components of the completed pipeline.

° Operation

Pump Horsepower - The hydraulic horsepower rating required of the pumps used to propel fuel through the pipeline.

Number of Pump Stations - The total quantity of pumping stations required for the total length to pump fuel at the specified rate through the total length.

Pressure Loss - The overall loss of fluid pressure due primarily to friction as fuel passes through pipeline.

Velocity - The average speed of fuel flow necessary to maintain the required rate of flow through the pipeline.

Fluid Temperature - The average temperature of fuel flowing through the pipeline, determined mainly by the climatic conditions of the pipeline location.

Reliability - Probability that the pipeline will continue in operation for a given period of time.

Maintainability - Probability of retaining an item in or restoring an item to operation under a given maintenance policy.

Vulnerability - A measurement of the potential for pipeline operation disruption by external forces (i.e. hostile action).

Service Life - The average expected length of time pipeline components will function before requiring replacement.

Number Parallel Lines - The number of parallel pipelines required to maintain a specified rate of flow.

° Pipe Physicals

Material - Pipe material and its properties (i.e. composition, density).

Product Contamination - The degree to which interior surfaces of pipe couplings and fittings affect the quality of the fluid being pumped through the pipeline.

Working Pressure - Average fluid pressures which fabricated pipe sections must withstand during normal pipeline operation.

Friction Factor - Hazen-Williams coefficient (usually 140-150).

Weight - The average weight (in pounds) of fabricated pipe sections per foot of length.

Diameter - Pipe diameter (in inches).

Wall Thickness - Half the difference between inside and outside pipe diameter dimensions (in inches).

Section Length - Average length (in feet) of fabricated pipe sections.

In addition, certain critical factors were given specified limits by the Government in accordance with their overall program requirements. These points are listed below:

- o The initial average daily throughput requirement will be not less than 10,000 barrels (420,000 gallons) consisting of a product mix of approximately 10 percent motor gasoline, 15 percent diesel fuel and 75 percent jet fuel.
- o The maximum average daily throughput requirement will not exceed 35,000 barrels (1,470,000 gallons) consisting of a product mix of 20 percent motor gasoline, 30 percent diesel fuel and 50 percent jet fuel.
- o The average distance from the port of entry to the bulk distribution breakdown point will be 100 miles.
- o Construction, operation and maintenance of the pipeline shall be possible in climatic categories 1, 2, 5, 6 and 7 as defined in AR 70-38.
- o The nominal size of each candidate pipeline shall be either 4, 6 or 8 inches. Use of multiple parallel lines to obtain required throughput requirements may be considered as an acceptable concept.
- o All pipeline system components and each item of required construction equipment shall be air-transportable in C-130 aircraft.

## Interrelationship of Design Factors

Following the definition of the external design constraints and the pipeline system characteristics, the next objective was the definition of the interrelationships among those factors. To aid in that determination, the factors were arranged in a matrix similar to that shown in Figure 1, as a visual means of readily assessing the interrelationship of the variables considered. The factors were listed as independent variables (row headings), dependent variables (column headings), or both. The external constraints, for example, could only be considered as independent variables. That is, they affected certain aspects of the system design, but in no way were affected by the system design. Conversely, such characteristics as the joining method for the pipe segments were affected by some factors of the system design and, in turn, themselves had a bearing upon others.

The relationships that were determined to be most significant are indicated by the location of the dots in Figure 1, which may be read in the following manner: "The skill level required of the installation crews (the tenth column heading) is a function of the equipment required for installation (the seventeenth row heading), the pipe joining method (the nineteenth row heading), and the suitability of the joining method to either pre-fabrication or pre-assembly (twenty-fourth row heading). As was the case with the original compilation of system design factors, the interactions shown were not intended to be all-inclusive, but were chosen to provide a reasonably constructed tool.



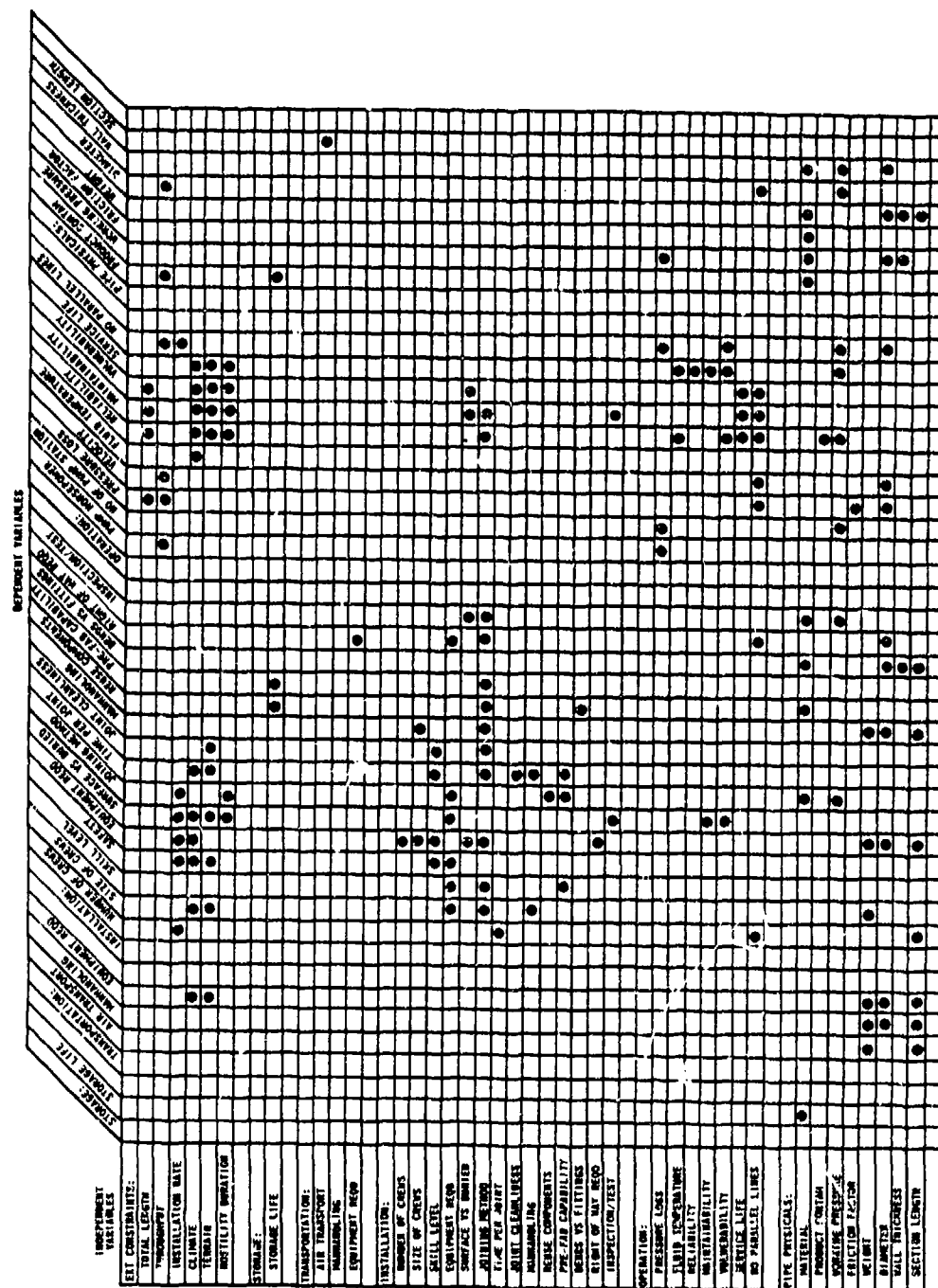


Figure 1: Design Factor Interrelationships

The functional relationships implied by Figure 1 were written in mathematical terms in the following listing. There, those having strict numerical relationships were written as complete equations.

$$\begin{aligned}ST &= f(MA) \\AT &= f(WE, SL) \\MT &= f(WE, DI, SL) \\ET &= f(CL, TN, WE, DI, SL)\end{aligned}$$

$$NC = 8.8 \frac{IR(TJ)(NL)}{SL}$$

NC non-dimensional  
IR in mi/day  
TJ in min/joint  
NL non-dimensional  
SL in ft

$$\begin{aligned}SC &= f(CL, TN, EI, JM, MI, WE) \\SK &= f(EI, JM, PF) \\SF &= f(IR, CL, TN, SK, EI) \\EI &= f(IR, CL, NC, SC, SK, SB, JM, RW, WE, DI, SL) \\SB &= f(IR, CL, TN, HD, EI, IT, MN, VL) \\JM &= f(IR, HD, EI, RC, PF, MA, WP) \\TJ &= f(CL, TN, SK, JM, JC, MI, PF) \\JC &= f(TN, SK, JM) \\MI &= f(SC, JM, WE, DI, SL) \\RC &= f(ST, JM, BF, MA) \\PF &= f(ST, JM) \\BF &= f(MA, DI, WT, SL) \\RW &= f(ET, EI, JM, NL, DI) \\IT &= f(SB, JM, MA, WP)\end{aligned}$$

$$PH = \frac{TP(PL)}{1714}$$

PH in hp  
PL in psi  
TP in gal/min

$$NP = \frac{PL}{WP}$$

NP non-dimensional  
PL in psi  
WP in psi

$$PL = 2.05 \times 10^4 TL \left[ \frac{TP}{NL(FF)DI^{2.63}} \right]^{1.85}$$

(Based on Hazen-Williams Equation)

PL in psi  
TL in miles  
TP in gal/min  
NL non-dimensional  
FF non-dimensional  
DI in inches

$$VE = \frac{.408 TP}{DI^2 (NL)}$$

VE in ft/sec  
TP in gal/min  
DI in inches  
NL non-dimensional

FT = f(CL)  
RL = f(TL, CL, TN, HD, JM, FT, VL, SE, NL, PC, WP)  
MN = f(TL, CL, TN, HD, SB, JM, IT, SE, NL)  
VL = f(TL, CL, TN, HD, SB, SE, NL)  
SE = f(CL, TN, HD, FT, RL, MN, VL, WP)  
NL = f(TP, IR, PL, VL, WP, DI)  
PC = f(TP, ST, MA)  
WP = f(PL, MA, DI, WT)  
FF = f(MA)

(Hazen-Williams Coefficient, usually 140-150)

$$WE = 226 MA (SL) (WT) (2 DI + WT)$$

MA in lb/in<sup>3</sup> (density)  
SL in ft  
WT in inches  
DI in inches

$$DI = f(TP, NL, WP)$$

$$WT = \frac{WP (DI)}{2 MA + .8 WP}$$

WP in psi  
DI in inches  
MA in psi (allowable stress)  
WP in psi

$$SL = f(AT)$$

These functions were developed primarily as an aid to the detailed definition of system concepts and as such will find more specific application in Phase II of the study. However, for the first phase some of the relations served as indicators to put some points of perspective into the overall system design problem.

For example, given a section length of 40 feet and an installation rate of 18.6 miles per day, the relation shown in Figure 2 indicates how rapidly the total number of installation crews for two 10-hour shifts increases with the time required to make the joints, almost to the point of excluding anything requiring more than 15 to 20 minutes.

Another instance of such a limitation is shown in Figure 3 where, given a throughput of 35,000 barrels per 22-hour day and a total system length of 100 miles, the graph indicates how rapidly the need for additional pumping stations increases with a decrease in working pressure. Related to this requirement are the reliability limits shown in Figure 4 where, even assuming a reliability of 1.00 for the pipeline itself, it can be seen for example, that if a system required 16 or more pumping stations, the overall system reliability could not exceed .85.

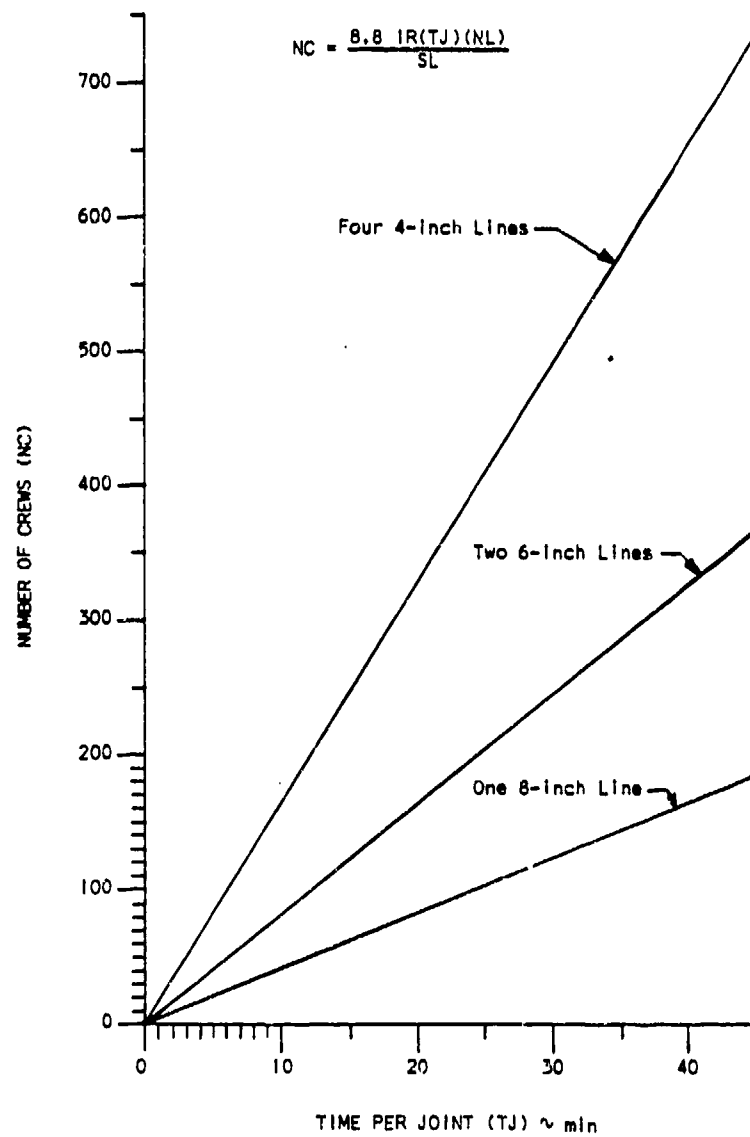


Figure 2: Number of Crews as a Function of Time per Joint

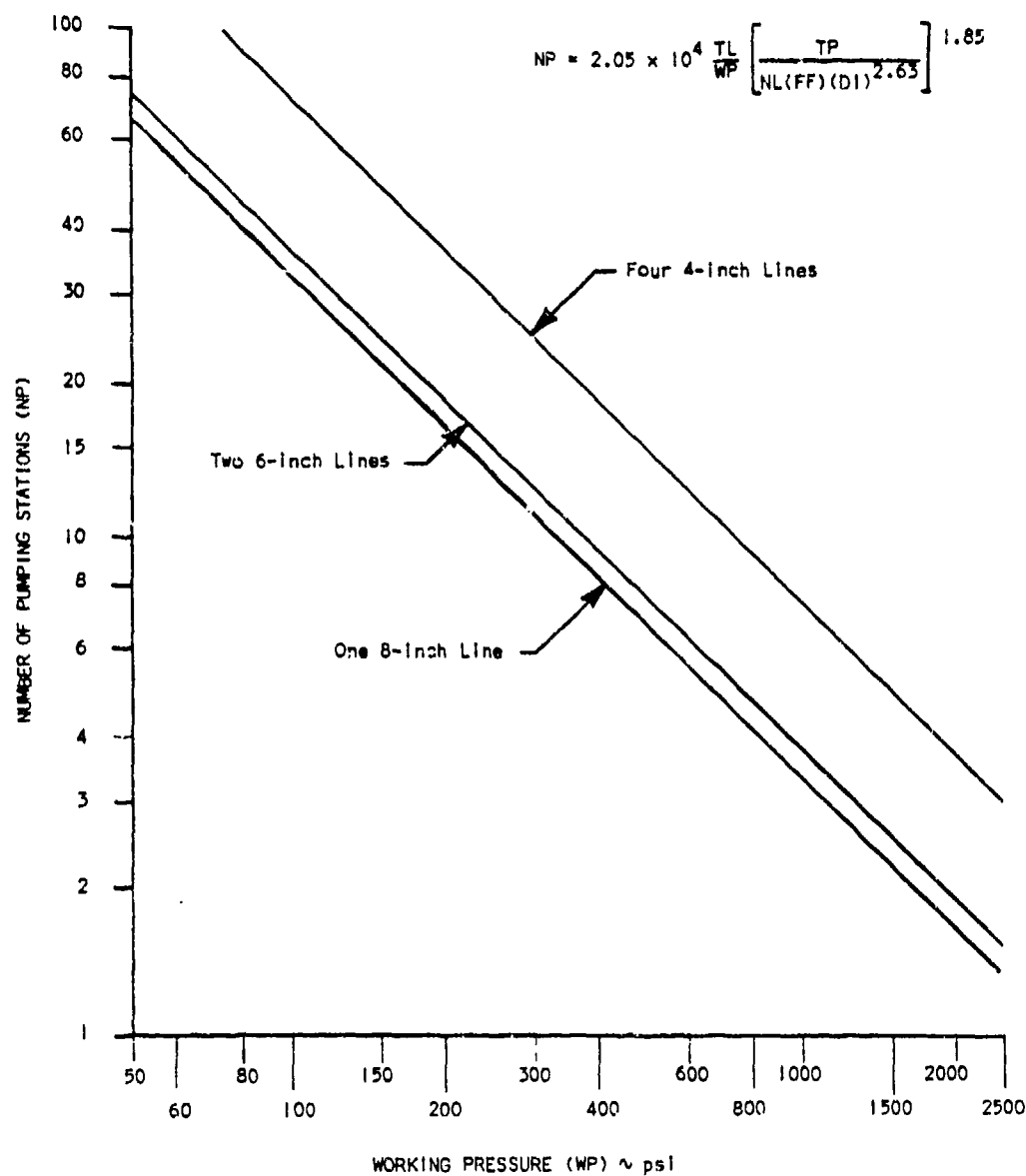


Figure 3: Number of Pumping Stations as a Function of Working Pressure

# REQUIRED PUMP STATION RELIABILITY

Number of Pump Stations	System Reliability				
	.75	.80	.85	.90	.95
1	.75	.80	.85	.90	.95
2	.87	.89	.92	.95	.97
3	.91	.93	.95	.97	.98
4	.93	.95	.96	.97	.99
5	.94	.96	.97	.98	.99
6	.95	.96	.97	.98	-
7	.96	.97	.98	.99	-
8	.96	.97	.98	.99	-
9	.97	.98	.98	.99	-
10	.97	.98	.98	.99	-
12	.98	.98	.99	-	-
14	.98	.98	.99	-	-
16	.98	.99	.99	-	-
18	.98	.99	-	-	-
20	.99	.99	-	-	-
22	.99	.99	-	-	-
24	.99	-	-	-	-
26	.99	-	-	-	-
28	.99	-	-	-	-
30	-	-	-	-	-
35	-	-	-	-	-

(Assuming 1.00 Pipe Reliability)

Figure 4: Pump Station Reliability as a Function of System Reliability and the Number of Stations

### Scoring Values

In order to employ the interrelationships or interactions between the design factors as a tool for comparison of the concepts, it was necessary to assign a value to each of the 162 relationships shown in Figure 1. Then each pair of concepts could be compared on the basis of each interaction.

The method which was employed is as follows:

(1) Each row entry was assigned a value based upon the number of designated interactions in that row. For example, the row labelled "Joining Method" has 12 interactions. The independent variable "Joining Method:", therefore, has a value of  $12/162$  on the basis of the 162 possible interactions.

(2) Each column entry was given a value based upon the number of interactions in that column and the values from step (1) of each of the rows interacting in that column. For example, the column labelled "Size of Crews" has six interactions whose row values total  $47/162$ . The dependent variable "Size of Crews" then has a value of  $6/(47/162)$ .

(3) The value for each individual interaction then was taken as the normalized product (rounded-off) of the row and column values. Using the same example as in steps (1) and (2) above, the product is  $(12/162)$  times  $[6/(47/162)]$  or 1.532. Normalizing on the maximum possible value of 2.000 (which occurs at the interaction of "Service Life" as a function of "Climate") the scoring value for the example is  $(1.532/2.000)10 = 7.66$  or, rounded off, 8, as shown in Figure 5 at the interaction of "Size of Crews" as a function of "Joining Method".

After the results were compiled, each interaction value was examined for plausibility. Any anomalies were reconciled through re-examination of the definitions of variables involved.



INDEPENDENT VARIABLES	DEPENDENT VARIABLES																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
LET CONSTRAINTS:																								
TOTAL LENGTH																								
THROUGHT																								
INSTALLATION RATE																								
CLIMATE																								
TERMIN																								
USABILITY QUALITY																								
STABILITY																								
STORAGE LIFE																								
TRANSPORTATION:																								
AIR TRANSPORT																								
EQUIPMENT REQ																								
INSTALLATION:																								
NUMBER OF CREWS																								
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MAINTAINABILITY																								
MAINTENANCE																								
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NO PARALLEL LINES																								
PIPE PHYSICALS:																								
MATERIAL																								
PRODUCT CONTAIN																								
WORKING PRESSURE																								
FRICTION FACTOR																								
WEIGHT																								
DIAMETER																								
WALL THICKNESS																								
SECTION LENGTH																								

Figure 5: Scoring Matrix

## Evaluation of Concepts

Due to the large number of concepts defined, the number of interactions shown in Figure 5, and the incompleteness of the data for some concepts, it was decided that a more basic set of design evaluation criteria than that of Figure 5 should be used to reduce the field of candidates. It was imperative, however, that as many variables as possible be considered.

The abbreviated matrix shown in Figure 6 was developed for this purpose. It required the specification of only four independent variables (Joining method, pipe material, working pressure, and weight), yet those four had a bearing upon 27 of the 36 dependent variables. The values used for each of the interactions were the same as those assigned in the full matrix.

Using this chart the concepts, taken in pairs, were scored by comparison. That is, the attributes of the two concepts were compared in each of the 36 points of consideration. In each instance the concept having the superior characteristics received the scoring value. In the case of equal qualifications or where sufficient data was unavailable, both concepts were awarded the value. Thus, the significance of the two total concept scores was not their magnitudes, but the difference between them.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000
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**Figure 6: Abbreviated Scoring Matrix**

## Results

The results of the Phase I investigation were the accumulation of a considerable amount of useful and current information on pipeline systems and installation methods and techniques, the definition of system concepts, the development of concept evaluation tools, and the selection of four concepts for further investigation.

## DISCUSSION

### Update of BPFS Findings

The BPFS Report was used as background information, and an attempt was made to contact all companies mentioned in the report in order to update the data and determine the extent of new developments in areas pertaining to piping, hardware, and welding techniques. Any additional information available on materials, joining devices and methods, and high speed pipeline construction methods also was solicited.

Of the 14 companies mentioned in the BPFS Report (see Appendix B) Mobile Pipe Constructors, manufacturer of a mobile pipe mill, and Frieberg and Fonnbeck, who were suppliers of a spiral weld tube mill, could not be located. Amercoat failed to reply to inquiries pertaining to FRP pipe systems and Westinghouse did not reply with information on its automatic welder.

Three companies indicated no further development of products since 1969. They are Aerojet-General with respect to explosive welding ("Shock-weld"), and Reynolds Aluminum and Rockwell International (North American Rockwell) with respect to automatic welders.

However, based on responses received, it was determined that six companies' products are currently available commercially. CIBA-Geigy (referenced in the BPFS Report as CIBA Products) currently has FRP pipe systems on the market as does A. O. Smith. Gustin-Bacon's and Victaulic's grooved pipe couplings, Race and Race's coupled hose/pipe and Zapata's (referenced as Anbeck's) "Buckle-Joint" are available commercially. It also was determined that CRC Automatic Welding (CRC-Crouse International) has developed an automatic welder applicable down to 24 inch diameter and

Is currently working on applications in the 12-24 inch diameter range.

All data furnished for currently available items was examined and incorporated in the concepts considered.

## Concepts Defined

On the basis of data obtained from the companies contacted, 30 pipeline concepts (see Appendix A) were identified and defined, collectively employing an assortment of conduit material and joining methods and techniques. The only systems eliminated from further consideration employed glass, wood, concrete, or lead pipe and, therefore, were not suitable for the specified military application.

Of the concepts selected for consideration, all employed either metallic pipe, non-metallic pipe, or hose. Joining methods included welding, adhesive bonding, couplings, friction, or mechanical means.

For purposes of identification a five-digit hexadecimal number was assigned to each concept, each digit representing a characteristic or parameter. The chart which follows (Figure 7) presents an explanation of the code. For example, the 2 in the identification code 2173D signifies the concept status (proposed during this study); the 1 indicates the joining method (mechanical coupling); the 7 indicates the joint geometry (separate fittings); the 3 indicates the joint description (thermal welding); and the D indicates the conduit material (polypropylene pipe).

Recognizing that application of any concept would fall into the near time-frame, it was necessary to consider only those concepts either commercially available now in the form specified or those requiring only adaptation or modification of equipment to meet the criteria. Any long-term process development was not deemed feasible, hence, no concepts requiring that type of development were considered.

Concepts defined included five systems currently used by the military: concepts 11112, 12342, 12343, 1234E, and 1240E (reference Appendix A). Three employ steel pipe and two use synthetic rubber hose; four are joined by

mechanical couplings and one welded; three couplings are bolted and one coupling employs a cam and groove catch.



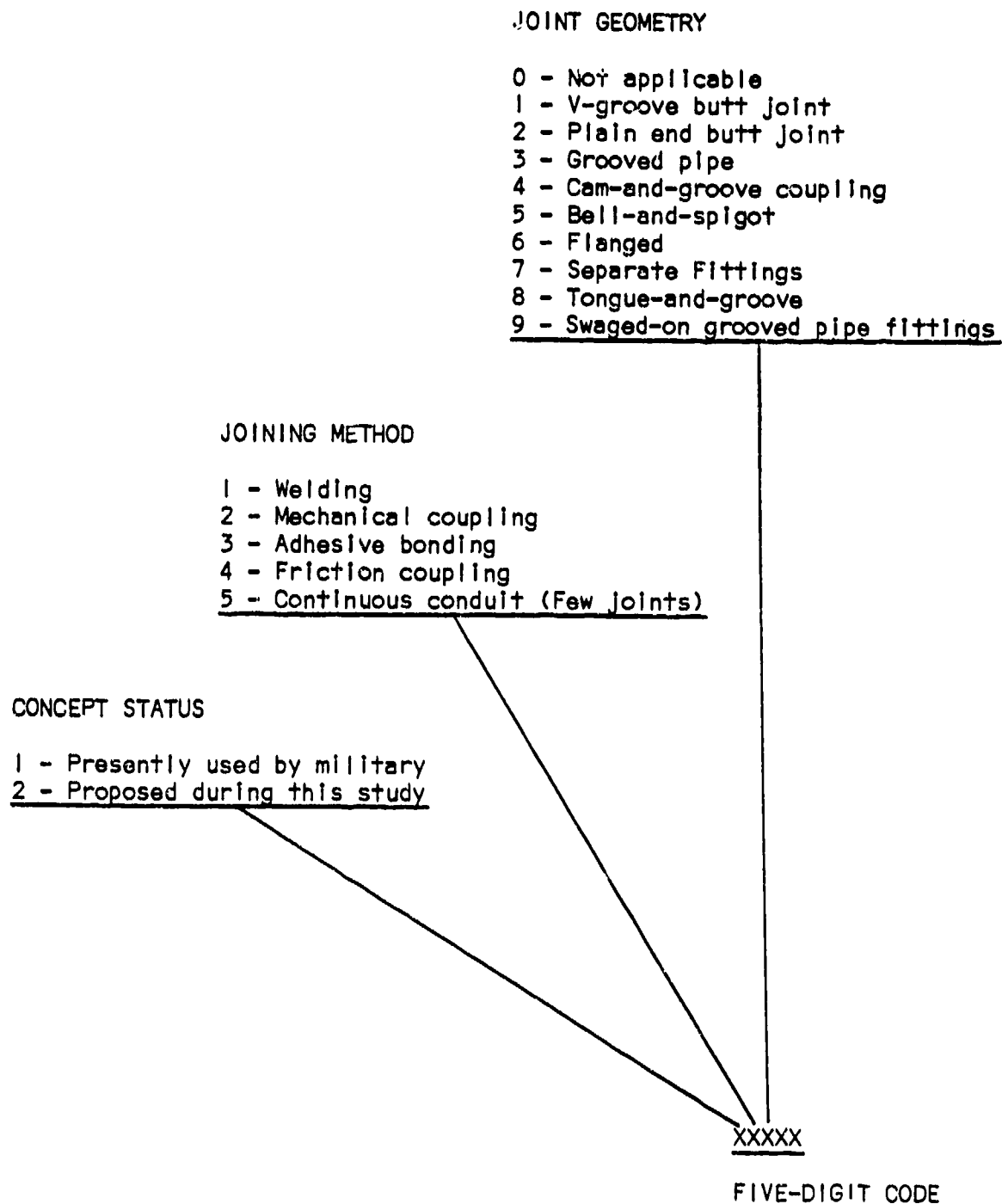


Figure 7: Concept Identification Codes

#### JOINT DESCRIPTION

- 0 - Not applicable
  - 1 - Manual welding
  - 2 - Automatic welding
  - 3 - Thermal welding
  - 4 - Bolted coupling
  - 5 - Wedge locking coupling
  - 6 - Latching coupling
  - 7 - Bolted gripping coupling
  - 8 - Rubber seal or "O" ring
  - 9 - Flange clamp and "O" ring
  - A - Locking strip
  - B - Butt-and-strap hand lay-up
  - C - Threaded
  - D - Male/Female threaded integral coupling
  - E - Swaging
  - F - Latching lugs
- 

#### CONDUIT MATERIAL

- 1 - Aluminum, schedule 40 pipe, 6061-T6 or 6063-T63
  - 2 - Steel, API 5L pipe, grade A or B
  - 3 - Steel, lightweight tubing
  - 4 - Steel, schedule 40 pipe
  - 5 - Steel, high-strength well casing
  - 6 - Steel, spiral welded pipe
  - 7 - Cast iron pipe
  - 8 - Ductile iron pipe
  - 9 - Polyvinyl chloride (PVC) pipe
  - A - Polyester resin fiberglass reinforced plastic (FRP) pipe
  - B - Epoxy resin fiberglass reinforced plastic pipe
  - C - High density polyethylene (HDPE) pipe
  - D - Polypropylene pipe
  - E - Synthetic rubber hose
- 

XXXXX

FIVE-DIGIT CODE

(Figure 7 cont'd)

## Results of Evaluation

The results of the evaluation of the concepts using the scoring matrix of Figure 6 is shown in Figure 8. There the concepts which were paired for comparison at the various stages of the elimination process are shown with their relative scores.

In Figure 8, three concepts (2123C, 2173D, and 2458C) received scores of zero. This was due to the fact that the materials involved, high density polyethylene (HDPE) and polypropylene, were found not to be compatible with the applicable petroleum products throughout the specified environmental temperature range. The merits or shortcoming of some of the other system concepts are listed below.

System Concept	Features	Disadvantages
11112	Reliability, Working Pressure	Skill level, Inspection, Time
12342	Skill level	Time, Weight
12343	Skill level, Weight	Working pressure, Vulnerability
1234E	Skill level, Time	Working pressure, Vulnerability
1240E	Skill level, Time, Weight	Working pressure, Reliability
21122	Reliability, Weld Quality	Skill level, Time
220DB	Skill level, Time, Weight	Working pressure

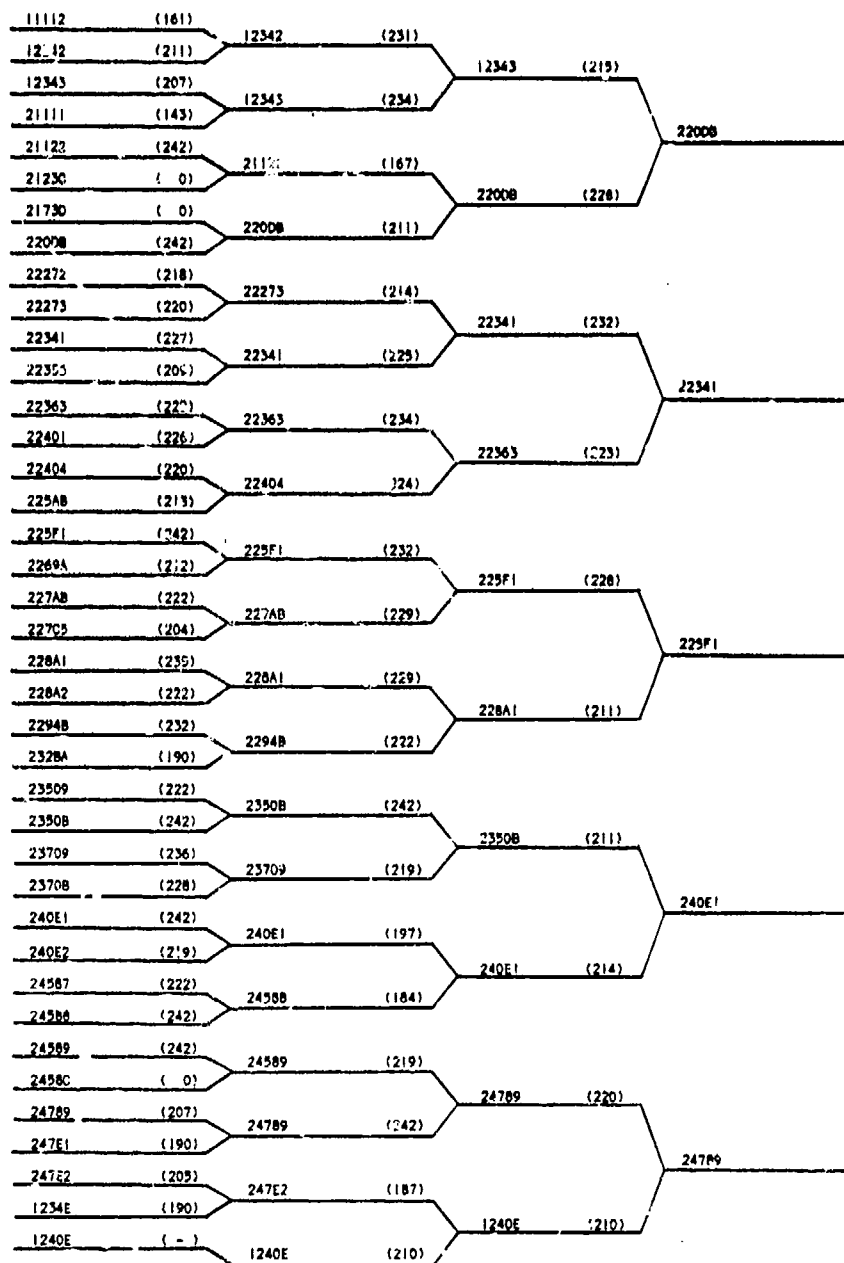


Figure 8: Elimination Scoring Results

22341	Skill level, Working pressure	Time, Vulnerability
22363	Skill level, Time	Working pressure, Vulnerability
225F1	Skill level, Time, Weight	Working pressure
228A1	Time, Weight, Working pressure	Skill level, Equipment required
2350B	Working pressure, Weight	Time
240E1	Working pressure, Weight, Time	Skill level, Equipment required
24789	Skill level, Weight, Time	Working pressure, Reliability

The details of the scoring in each comparison are shown in Appendix E.

The five concepts which survived the elimination process are shown in Figures 9 through 13. In general, the qualities exhibited by all five were relatively light weight, relatively fast joining times, and relatively low skill levels required. This was, however, accomplished at the expense of lower operating pressures and increased vulnerability in some cases.

Concept Code 220DB

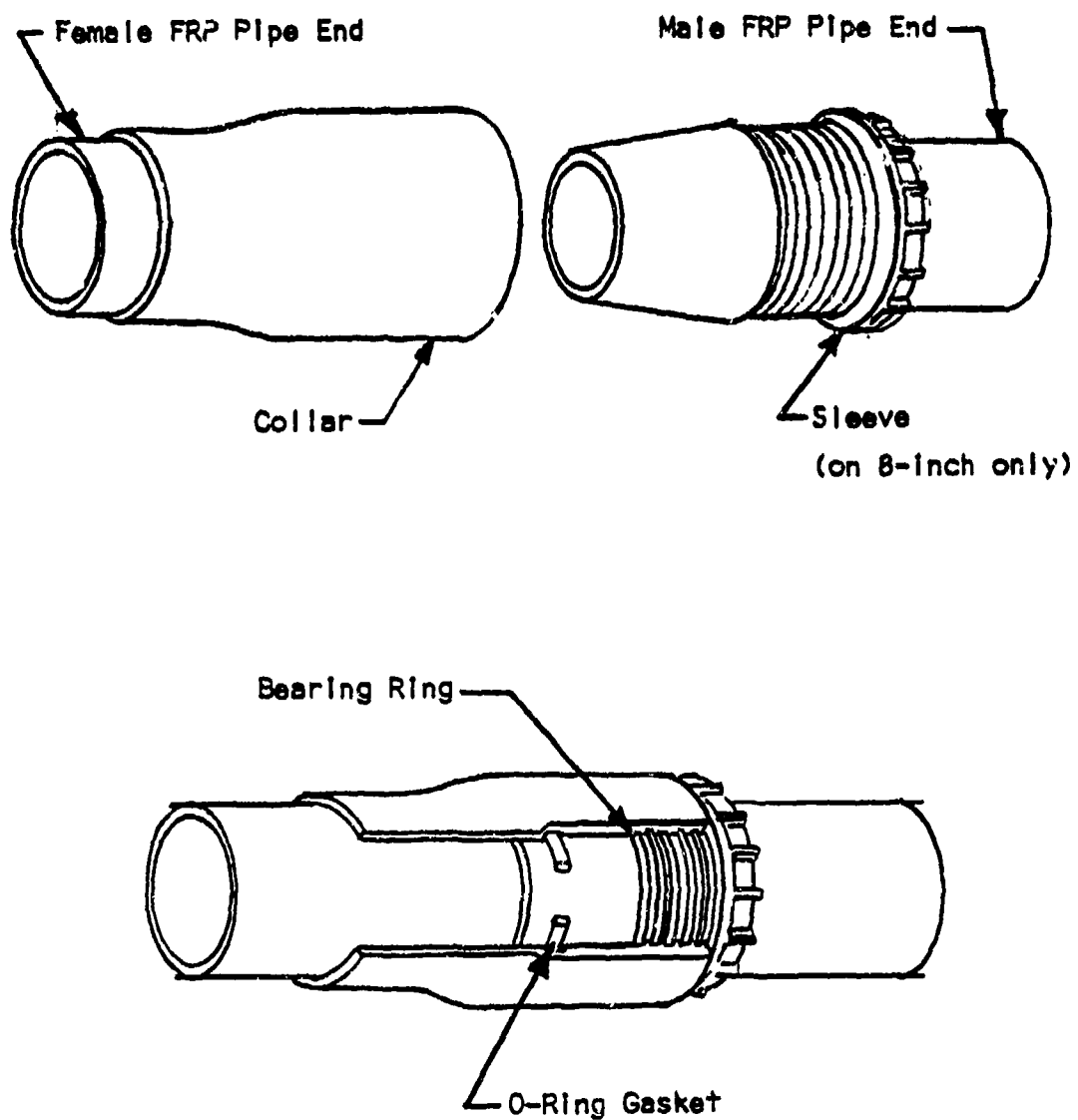


Figure 9: CIBA-Geigy "Pronto-Lock" Joint

Concept Code 22341

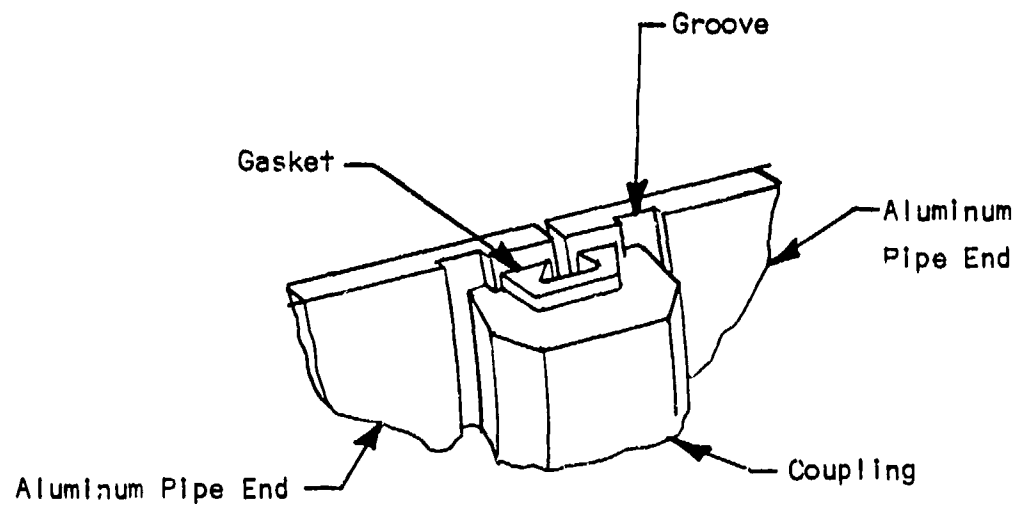
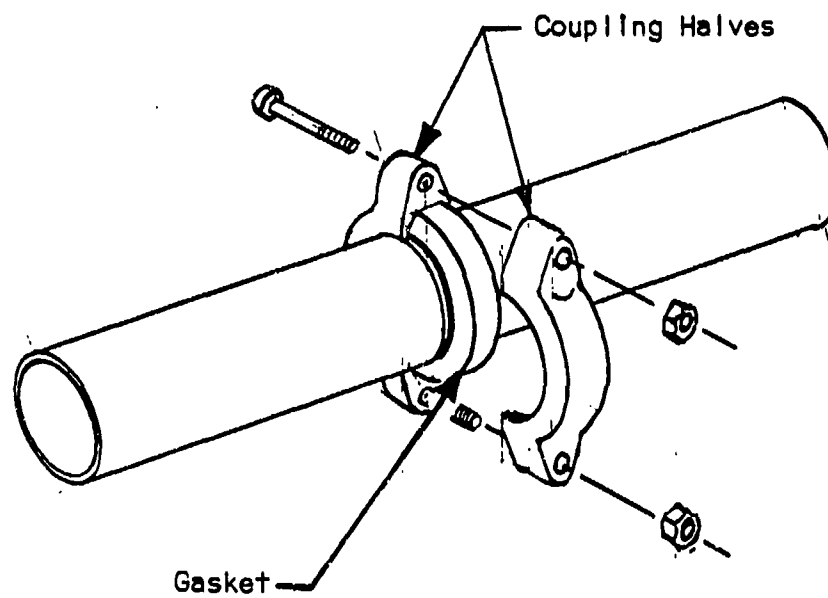


Figure 10: Bolted Grooved-Pipe Coupling Joint

Concept Code 225F1

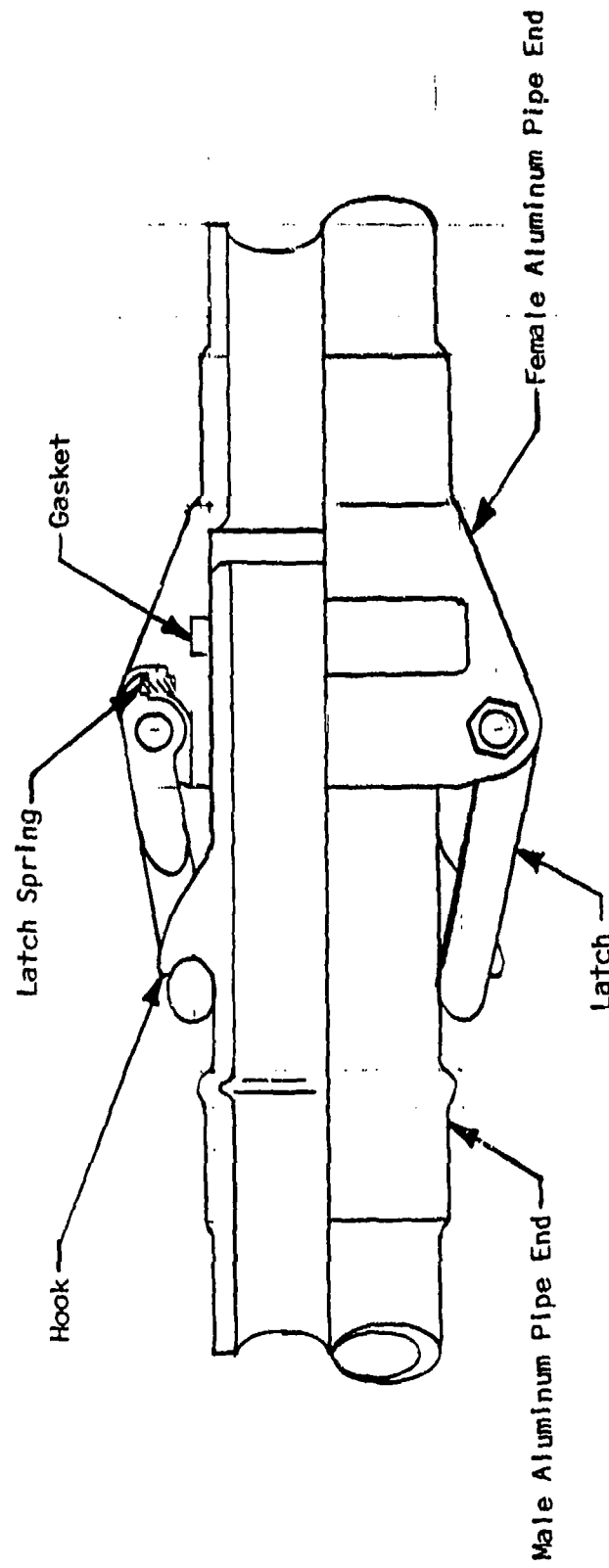


Figure 11: Race and Race "Raceblitz" Joint



Concept Code 240EI

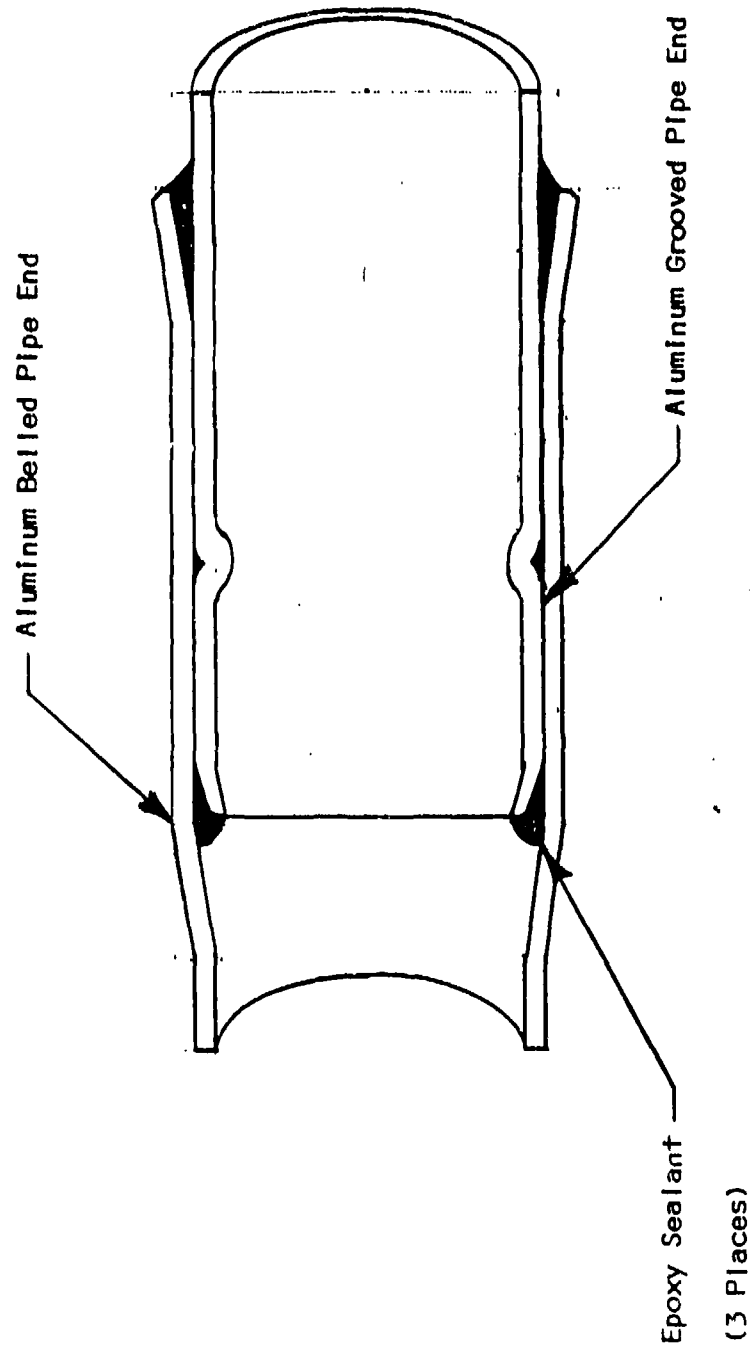


Figure 12: Zapata Pipeline Technology "Zap-Lok" Joint

Concept Code 24789

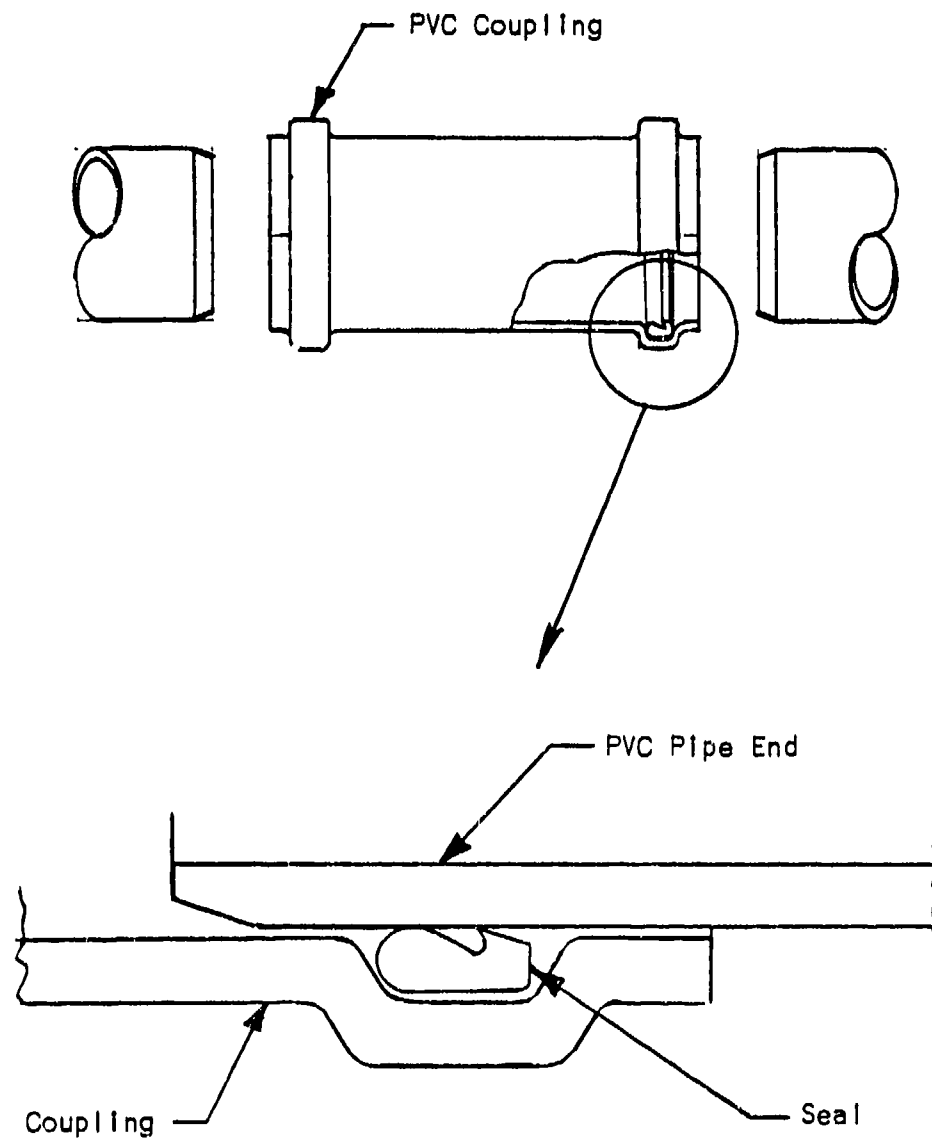


Figure 13: Seal Friction Coupling Joint

### Comparison to Existing Systems

Since the present military systems were not represented in each major branch of Figure 8, it was necessary to rate each of the five proposed concepts against each of the five present systems in order to establish their relative merit. The results of this are shown in Figure 14. In every case it can be seen that using the limited criteria established, the proposed concepts outweigh the present systems. The numbers in parentheses below the proposed concept codes are the total of the differences between the concepts scores and the present systems' scores. The details of the scoring of each comparison are shown in Appendix F.

		PRESENT MILITARY SYSTEMS				
		11112	12342	12343	1234E	1240E
PROPOSED CONCEPTS	2200B (117)	172 222	215 228	215 228	207 223	207 232
	22341 (117)	180 228	227 242	223 242	195 222	215 223
	225F1 (130)	180 220	204 220	208 228	205 232	215 242
	240E1 (135)	199 242	173 205	180 205	183 208	200 210
	24789 (113)	183 222	199 222	207 222	194 220	210 220

Figure 14: Present Systems Compared to Proposed Concepts

### Concepts Selected

The four concepts selected are those with the highest scoring values overall and represent those concepts remaining after the evaluation process which indicate, on the basis of performance, the greatest potential for military application. The four concepts, 220DB, 22341, 225F1, and 240E1, on the basis of initial assessment, would meet the specified criteria. Three employ aluminum pipe, while one uses fiberglass reinforced plastic pipe. All are joined by methods basically available commercially.

The fifth concept from Figure 14 was eliminated from further consideration because of its lower scores and due to anticipated seepage rates higher than would be acceptable. That is, in the usual application for that type of pipe (water lines), relatively high seepage at the joints is allowed as the minimum quality level of the pipe. Development of that concept would, therefore, require changes in specified tolerances, manufacturing methods, and/or the geometry of the proprietary seal involved. While this could undoubtedly be accomplished, the other four concepts do not have problems of this nature.

### Future Actions

The Phase II investigation will assess, in detail, the effectiveness for each of the four selected pipeline concepts as components of the overall system for the distribution of bulk fuel. Particular attention will be directed to costs involved.

## CONCLUSIONS

The Phase I investigation has yielded the following conclusions:

- o On the basis of contact with professional and trade organizations and private industry, only a few areas of pipeline technology have shown marked progress or development in the last several years. For example, automatic welding techniques have improved the quality of joints, but because there has been no reduction in time required, rapid pipeline installation is not possible. Hose is relatively versatile, can be easily transported and installed, but its application is limited by its low working pressures.

- o As a result of the information obtained and on the basis of preliminary findings, the development of an effective concept for rapid installation of a system for distribution of bulk fuel appears feasible.

- o All four concepts under consideration appear to be superior, on the limited basis of the preliminary evaluation to the military systems currently available.

## REFERENCES

1. Bulk Petroleum Facilities and Systems (BPFS) - 1970-1985; Technical Operations, Inc.; Alexandria, Va.; November 1969.
2. Technical Evaluation of Automatic Processes and Equipment for Welding Pipeline Girth Joints; P. R. Habicht, et al; Battelle Memorial Institute; Columbus, Oh.; May 16, 1969.
3. FM 10-20; Organization Maintenance - Military Petroleum Pipelines, Tanks, and Related Equipment; Dept. of the Army; Washington, D. C.; May 1974.
4. FM 10-67; Petroleum Supply In Theaters of Operations; Dept. of the Army; Washington, D. C.; October 1968.
5. TM 5-343; Military Petroleum Pipeline Systems; Dept. of the Army; Washington, D. C.; February 1969.
6. TM 10-1101; Petroleum Handling Equipment and Operation; Dept. of the Army; Washington, D. C.; May 1972.
7. MII-A-8421F; "Air Transportability Requirements, General Specification for"; 25 October 1974.
8. MII-H-52262A; "Hose Assembly, Rubber: Lightweight, Collapsible, 4-Inch"; 13 March 1970.
9. MII-H-82127; "Hose Assembly, Rubber (Synthetic); Fuel, Discharge, Lightweight"; 6 June 1966.
10. AR 70-38; Research, Development, Test, and Evaluation of Material for Extreme Climatic Conditions; Dept. of the Army; Washington, D. C. 5 May 1969.
11. MII-HDBK-759; Human Factors Engineering Design for Army Materiel; U. S. Army Missile Command; Redstone Arsenal, Al.; 12 March 1975.
12. API 5L; "Specification for Line Pipe"; American Petroleum Institute; Dallas, Tx.; 21st Edition, March 1965.
13. ASTM B345; "Aluminum Alloy Seamless Extruded Tube and Seamless Pipe for Gas and Oil Transmission and Distribution Piping Systems"; American Society for Testing and Materials; Philadelphia, Pa.; 1973.



APPENDIX A

Descriptions of Concepts

Concept Code 11112

Description: This concept code represents a pipeline type currently used by the military. It employs steel, API 5L pipe, grade A or B, joined by manual welding. Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 10.00 LB/FT, 14.97 LB/FT, and 22.34 LB/FT, respectively; corresponding working pressures are 1700 psi, 1200 psi, and 1000 psi, respectively.

Concept Code 12342

Description: This concept code represents a conventional type pipeline employing steel, API 5L pipe grade A or B, with grooved pipe couplings, such as, Victualic style 77 or Gustin-Bacon No. 100 bolted couplings. Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 10.00 LB/FT, 14.97 LB/FT, and 22.34 LB/FT, respectively; corresponding working pressures are 1000 psi, 1000 psi, and 800 psi, respectively.

Concept Code 12343

Description: This concept code represents a conventional type pipeline employing lightweight steel tubing with welded end nipples. The joining method is the same as that used in concept code 12342, above. Weights of 4 inch, 6 inch and 8 inch diameter tubing are 3.53 LB/FT, 7.28 LB/FT, and 9.51 LB/FT, respectively; corresponding working pressures are 600 psi, 600 psi, and 500 psi, respectively.

Concept Code 1234E

Description: This concept code represents a pipeline type currently used by the military. It employs synthetic rubber hose assemblies as covered by MIL-H-52262, joined by grooved pipe couplings. Weight of 4 inch diameter hose is 1.65 LB/FT, with a working pressure of 125 psi (500 burst/225 proof).

Concept Code 1240E

Description: This concept code represents a pipeline type currently used by the military. It employs synthetic rubber hose assemblies as covered by MIL-H-82127, joined by car and groove couplings. Weights of 4 inch and 6 inch diameter hoses are 1.25 LB/FT and 2.3 LB/FT, respectively; corresponding working pressure is 100 psi for both diameters (400 burst/200 proof).

#### Concept Code 21111

Description: This concept code represents a proposed pipeline employing aluminum, schedule 40, 6061-T6 pipe, joined by manual welding. Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 3.73 LB/FT, 6.56 LB/FT, and 9.83 LB/FT, respectively; corresponding working pressures are 1000 psi, 800 psi, and 650 psi, respectively.

#### Concept Code 21122

Description: This concept code represents a proposed pipeline employing steel, API 5L pipe, grade A or B, joined by automatic welding equipment, such as, that available from Dimetrics, Astro-Arc, or Sciaky Bors. Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 10.0 LB/FT, 14.97 LB/FT, and 22.34 LB/FT, respectively; corresponding working pressures are 1700 psi, 1200 psi, and 1000 psi, respectively.

#### Concept Code 21230

Description: This concept code represents a pipeline employing high density polyethylene (HDPE) pipe, joined by thermal welding, such as Ryerson "Monoline" and M. L. Sheldon "Sclairpipe". Weights of 4 inch, 6 inch, and 8 inch pipe are 2.77 LB/FT, 5.99 LB/FT, and 9.35 LB/FT, respectively; corresponding working pressure is 160 psi for all diameters.

#### Concept Code 21730

Description: This concept code represents a pipeline employing Schedule 40 polypropylene pipe, joined by thermally welded, separate fittings (R & G Sioane "Fuseal"). Weight of 4 inch and 6 inch diameter pipes are 1.87 LB/FT and 3.56 LB/FT, respectively; corresponding working pressures are 125 psi and 100 psi, respectively.

#### Concept Code 22008

Description: This concept code represents a proposed pipeline employing epoxy resin fiberglass reinforced plastic pipe, joined by CIBA-Geigy "Pronto-Lock" and "Pronto-Lock II" male/female integral threaded couplings. Weights for 4 inch, 6 inch, and 8 inch diameter pipes are 0.8 LB/FT, 1.7 LB/FT, and 3.3 LB/FT, respectively; corresponding working pressures are 300 psi, 200 psi, and 150 psi, respectively.

#### Concept Code 22272

Description: This concept code represents a proposed pipeline employing steel, API 5L pipe, Grade A or B, joined by Gustin-Bacon No. 200 bolted gripping couplings. Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 10.00 LB/FT, 14.97 LB/FT, and 22.34 LB/FT, respectively; corresponding working pressures are 1000 psi, 600 psi, and 500 psi, respectively.

Concept Code 22273

Description: This concept code represents a proposed pipeline employing lightweight steel tubing, joined by the same mechanical coupling as that used in Concept Code 22272, above. Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 3.53 LB/FT, 7.28 LB/FT, and 9.51 LB/FT, respectively; corresponding working pressures are 600 psi, 600 psi, and 500 psi, respectively.

Concept Code 22341

Description: This concept code represents a proposed pipeline of a type not currently used by the military. Conduit material is aluminum, schedule 40, 6061-T6. Sections are joined by grooved pipe couplings, such as, Gustin-Bacon No. 101 bolted coupling. Weights of 4 inch, 6 inch, and 8 inch diameter pipe are 3.73 LB/FT, 6.56 LB/FT, and 9.88 LB/FT, respectively; corresponding working pressures are 1000 psi, 1000 psi, and 800 psi, respectively.

Concept Code 22356

Description: This concept code represents a proposed pipeline employing spiral-welded steel pipe, joined by Naylor "Wedgelock" wedge locking grooved-pipe couplings. Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 3.96 LB/FT, 7.94 LB/FT, and 13.20 LB/FT, respectively; corresponding working pressure is 400 psi for each diameter.

Concept Code 22363

Description: This concept code represents a proposed pipeline of a type not currently used by the military. Conduit material consists of lightweight steel tubing with welded end nipples. Sections are joined by latching grooved pipe couplings, such as, Victaulic style 78 or Gustin-Bacon No. 115. Weights of 4 inch, 6 inch, and 8 inch diameter tubing are 3.53 LB/FT, 7.28 LB/FT, and 9.51 LB/FT, respectively; corresponding working pressures are 300 psi, 300 psi, and 300 psi, respectively.

Concept Code 22401

Description: This concept code represents a proposed pipeline employing aluminum, schedule 40, 6061-T6 pipe, joined by cam and groove type couplings, such as, Andrews 400A, 400D, 600A, 600D, 800A, 800D, or OPW 633-A, 633-D NPT female threads (aluminum). Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 3.73 LB/FT, 6.56 LB/FT, and 9.88 LB/FT, respectively; corresponding working pressures are 100 psi, 75 psi, and 50 psi, respectively.

Concept Code 22404

Description: This concept code represents a proposed pipeline employing steel, schedule 40 pipe, joined by cam and groove type couplings, such as, Andrews 400A, 400D, 600A, 600D, 800A, 800D or OPW 633-A, 633-D NPT female threads (steel). Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 10.79 LB/FT, 18.97 LB/FT, and 28.55 LB/FT, respectively; corresponding working pressure is 100 psi for the 4 and 6 inch diameters.

Concept Code 224AB

Description: This concept code represents a proposed pipeline employing filament wound epoxy resin fiberglass reinforced plastic pipe, joined by bell and spigot coupling with locking key strip, such as those available from Brunswick and Fiberglass Resources.

Concept Code 225FI

Description: This concept code represents a proposed pipeline employing aluminum 6063-T63 pipe, joined by Race and Race "Racebilt" bell and spigot coupling with "O" ring and latching lugs. Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 1.35 LB/FT, 3.06 LB/FT, and 4.64 LB/FT, respectively; corresponding working pressure is 350 psi for each diameter.

Concept Code 2269A

Description: This concept code represents a proposed pipeline employing filament wound polyester resin fiberglass reinforced plastic (FRP) pipe, joined by Beetle "Quick-Lock" flange clamp with "O" ring. Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 1.5 LB/FT, 2.7 LB/FT, and 4.1 LB/FT, respectively; corresponding working pressures are 200 psi, 200 psi, and 150 psi, respectively.

Concept Code 227AB

Description: This concept code represents a proposed pipeline employing epoxy resin fiberglass reinforced plastic pipe, joined by Fiberglass Resources' "Kwik-Key" coupling with "O" ring and locking strip. Weights of 4 inch, 6 inch, and 8 inch diameter pipes are .8 LB/FT, 1.6 LB/FT, and 2.7 LB/FT, respectively; corresponding working pressures are 350 psi, 250 psi, and 260 psi, respectively.

Concept Code 227C5

Description: This concept code represents a proposed pipeline employing high strength well casing steel pipe, joined by Armco "Seal Lock" threaded well casing couplings. Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 11.60 LB/FT, 23.00 LB/FT, and 32.00 LB/FT, respectively; corresponding working pressures are 2100 psi, 1700 psi, and 1500 psi, respectively.

Concept Code 228A1

Description: This concept code represents a proposed pipeline employing aluminum, schedule 40 pipe, joined by Sandia Labs' male/female tongue and groove coupling with locking strips ("Taped Joint"). Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 3.73 LB/FT, 6.56 LB/FT, and 9.88 LB/FT, respectively; corresponding working pressures are 1700 psi, 1200 psi, and 1000 psi, respectively.

Concept Code 228A2

Description: This concept code represents a proposed pipeline employing steel, API 5L pipe, Grade A or B, joined by the same coupling as that used in Concept Code 228A1, above. Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 10.00 LB/FT, 14.97 LB/FT, and 22.34 LB/FT, respectively; corresponding working pressures are 1700 psi, 1200 psi, and 1000 psi, respectively.

Concept Code 2294B

Description: This concept code represents a proposed pipeline employing epoxy resin fiberglass reinforced plastic pipe, joined by "Gamagrip" swaged-on grooved pipe couplings. Weights of 4 inch and 6 inch diameter pipes are .8 LB/FT and 1.7 LB/FT, respectively; corresponding working pressures are 225 psi and 250 psi, respectively.

Concept Code 232BA

Description: This concept code represents a proposed pipeline employing filament wound polyester resin fiberglass reinforced plastic (FRP) pipe, joined by butt and strap hand lay-up of resin and mat, such as that available from Century Fiberglass. Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 1.5 LB/FT, 2.7 LB/FT, and 4.1 LB/FT, respectively; corresponding working pressure is 150 psi for each diameter.

Concept Code 23509

Description: This concept code represents a proposed pipeline employing polyvinyl chloride (PVC) pipe, joined by cemented (adhesive bonded) bell and spigot couplings, such as those available from Certain-Teed. Weights of 4 inch and 6 inch diameter pipes are 1.822 LB/FT and 3.947 LB/FT, respectively; corresponding working pressure is 200 psi for both diameters.

Concept Code 2350B

Description: This concept code represents a proposed pipeline employing epoxy resin fiberglass reinforced plastic pipe, joined by cemented (adhesive bonded) bell and spigot couplings, such as those available from Fiberglass Resources, Fiber Cast, and Koch. Weights for 4 inch, 6 inch and 8 inch diameter pipes are .8 LB/FT, 1.6 LB/FT, and 2.7 LB/FT, respectively; corresponding working pressures are 350 psi, 250 psi, and 260 psi, respectively.

Concept Code 23709

Description: This concept code represents a proposed pipeline employing polyvinyl chloride (PVC) pipe, joined by cemented (adhesive bonded) fittings, such as those available from Certain-Teed and Dixie Plastics. Weight of 4 inch, 6 inch, and 8 inch diameter pipes are 1.822 LB/FT, 3.947 LB/FT, and 6.679 LB/FT, respectively; corresponding working pressure is 200 psi for each diameter.

Concept Code 2370B

Description: This concept code represents a proposed pipeline employing epoxy resin fiberglass reinforced plastic (FRP) pipe, joined by Conley FRP cemented (adhesive bonded) fittings. Weights for 4 inch, 6 inch, and 8 inch diameter pipes are .8 LB/FT, 1.6 LB/FT, and 2.7 LB/FT, respectively; corresponding working pressure is 150 psi for each diameter.

Concept Code 240E1

Description: This concept code represents a proposed pipeline employing aluminum, schedule 40, 6061-T6 pipe, joined by Zapata "Zap-Lok" swaged bell and spigot friction coupling. Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 3.73 LB/FT, 6.56 LB/FT, and 9.88 LB/FT, respectively; corresponding working pressures are 1700 psi, 1200 psi, and 1000 psi, respectively.

Concept Code 240E2

Description: This concept code represents a proposed pipeline employing steel, API 5L pipe, Grade A or B, joined by the same method as that used in Concept Code 240E1, above. Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 10.00 LB/FT, 14.97 LB/FT, 22.34 LB/FT, respectively; corresponding working pressures are 1700 psi, 1200 psi, and 1000 psi, respectively.

Concept Code 24587

Description: This concept code represents a pipeline employing cast iron pipe, joined by a bell and spigot type friction joining mechanism with an "O" ring seal, such as McWane "Tyton" and American "Fastite". Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 15 LB/FT, 23.9 LB/FT, and 34.7 LB/FT, respectively; corresponding working pressure is 350 psi for each diameter.

Concept Code 24588

Description: This concept code represents a pipeline employing ductile iron pipe, joined by a bell and spigot type friction joining mechanism with an "O" ring seal, such as McWane "Tyton" and American "Fastite". Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 13.4 LB/FT, 21 LB/FT, and 29.7 LB/FT, respectively; corresponding working pressure is 350 psi for each diameter.

Concept Code 24589

Description: This concept code represents a proposed pipeline employing polyvinyl chloride (PVC) pipe, joined by bell and spigot coupling with rubber seal, such as ASC Plastics' "Vulcan" with integral coupler; Certain-Teed "Fluid-Tite"; Clow "Bell-Tite"; Ethyl "Bell-Ring"; Johns-Manville "Ring-Tite"; Rehau "Mechan-O-Joint". Weights for 4 inch, 6 inch, and 8 inch diameter pipes are 1.86 LB/FT, 4.05 LB/FT, and 6.91 LB/FT, respectively; corresponding working pressure is 200 psi for each diameter.

Concept Code 2458C

Description: This concept code represents a pipeline employing high density polyethylene (HDPE) duct, with a bell and spigot type friction joining mechanism with an "O" ring seal, such as Phillips Products "Driscon 3700". Weights for 4 inch and 6 inch line are .96 LB/FT and 1.82 LB/FT, respectively; corresponding working pressure is 75 psi for both diameters.



Concept Code 24789

Description: This concept code represents a proposed pipeline employing polyvinyl chloride (PVC) pipe, joined by Tridyn "Wedge-Tite" friction coupling with rubber seal. Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 1.48 LB/FT, 3.22 LB/FT, and 5.44 LB/FT, respectively; corresponding pressure is 200 psi for each diameter.

Concept Code 247E1

Description: This concept code represents a proposed pipeline employing aluminum schedule 40, 6061-T6 pipe, joined by McDonnell "Duraswage" swaged friction couplings. Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 3.73 LB/FT, 6.56 LB/FT, and 9.88 LB/FT, respectively; corresponding working pressures are 1700 psi, 1200 psi, and 1000 psi, respectively.

Concept Code 247E2

Description: This concept code represents a proposed pipeline employing steel, API 5L pipe, Grade A or B, joined by the same method as that used in Concept Code 247E1, above. Weights of 4 inch, 6 inch, and 8 inch diameter pipes are 10.00 LB/FT, 14.97 LB/FT, and 22.34 LB/FT, respectively; corresponding working pressures are 1700 psi, 1200 psi and 1000 psi, respectively.

APPENDIX B

Companies Mentioned in BPFS Report

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used In Concepts</u>
Aerojet-General Corporation (AOMC) 9236 East Hall Road Downey, California 90241		X		
Aeroquip Gustin-Bacon Division Post Office Box 927 Lawrence, Kansas 66044		X	X	X
Amercoat Corporation Ameron Corrosion Control Division Brea, California 92621				
Anbeck Company Post Office Box 19415 Houston, Texas 77024 (See Zapata)				
CIBA-Geigy Corporation Pipe Systems Department 9900-T Northwest Freeway Houston, Texas 77018		X	X	X
CIBA Products Company 556 Morris Avenue Summit, New Jersey 07901 (See Ciba-Geigy)				
CRC-Crose International, Incorporated Post Office Box 3227 Houston, Texas 77024		X	X	
Frieberg and Fonnbeck Associates Post Office Box 2127 Fullerton, California 92633	X			
Gustin-Bacon Division Certain-Teed Products Corporation Post Office Box 15079-S Kansas City, Kansas 66115 (See Aeroquip)				
Mobile Pipe Constructors, Incorporated 16 Edgewater Drive Belvedere, California 94920				
Mohr, Glen Post Office Box 52 Linthicum, Maryland 21090 (See Mobile Pipe Constructors)		X		
Race and Race, Incorporated Post Office Box 1400 Winter Haven, Florida 33880		X	X	X

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Reynolds Aluminum Company Post Office Box 27003-ZA Richmond, Virginia 23261		X	X	
Rockwell International North American Aviation Group 1700 East Imperial Highway El Segundo, California 90245		X		
Smith, A. O., Corporation Reinforced Plastics Division 2700 West 65th Street Little Rock, Arkansas 72209		X	X	X
Victaulic Company of America 3102 Hamilton Boulevard South Plainfield, New Jersey 07080		X	X	X
Westinghouse Electric Corporation Industrial Equipment Division Post Office Box 300 Sykesville, Maryland 21784				
Zapata Pipeline Technology, Incorporated 2521 Fairway Park Drive Suite 420 Houston, Texas 77018		X	X	X

APPENDIX C

New Companies Contacted

<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
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Aanonson Sprinkler Company  
5434 East Tulare Street  
Fresno, California 93727

Abbeon Cal, Incorporated  
123-33 F Gray Avenue  
Santa Barbara, California 93101

X

Abbott Rubber Company  
2482 Delta Lane  
Elk Grove Village, Illinois 60007

X

X

Academy Metal Products Company, Incorporated  
10 Edward Hart Drive  
Jersey City, New Jersey 07305

Adadia Plastics, Incorporated  
East Bethpage Road  
Plainview, New York 11803

Accurate Machine Products Corporation  
712 West Walnut Street  
Johnson City, Tennessee 37601

Ace Irrigation and Manufacturing Company  
Kearney Air Force Base  
Kearney, Nebraska 68847

Acer and Whedon, Incorporated  
216 Commercial  
Medina, New York 14103

X

Acipco Steel Products  
Division of American Cast Iron Pipe Company  
2900 16th Street, North  
Birmingham, Alabama 35207

Acme-Hamilton Manufacturing Corporation  
Post Office Box 361  
Trenton, New Jersey 08603

X

Acme Tube, Incorporated  
1 Somerset Valley Industrial Campus  
Somerset, New Jersey 08873

Action Plastics Company  
52 Furler Street  
Totowa, New Jersey 07511

Adam Metal Supply  
625 Evans Street  
Elizabeth, New Jersey 07072

<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used In Concepts</u>
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Adams Company  
1477 McCarter Highway  
Newark, New Jersey 07104

AFC, Incorporated  
Highway 52, South  
Chatfield, Minnesota 55923

A & G Plastic Products, Incorporated Post Office Box 838A Sturgis, Michigan 49091	X		
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AGL Welding Supply Company  
600T U. S. Highway No. 46  
Clifton, New Jersey 07015

Air Plastics, Incorporated  
Post Office Box 42067  
9707 Kenwood Road  
Cincinnati, Ohio 45242

Alaskan Copper and Brass Company  
3223 Sixth Avenue, South  
Seattle, Washington 98134

Alaskan Copper Works  
3609 East Marginal Way  
Seattle, Washington 98134

Albert Equipment Company, Incorporated  
Post Office Box 45688  
Tulsa, Oklahoma 74145

Albert Pipe Supply Company, Incorporated 109 Varick Avenue Brooklyn, New York 11237	X		
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Alcan Aluminum Corporation  
100 Erieview Plaza  
Cleveland, Ohio 44114

Alert Steel Products Company  
3110 East 87th Street  
Chicago, Illinois 60617

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used In Concepts</u>
All Boro Metal Products Company, Incorporated 608 Fenimore Road Mamaroneck, New York 10543		X		
Allegheny-Ludlum Steel Corporation Division of Allegheny-Ludlum Industries, Incorporated Department TR, Oliver Building Pittsburgh, Pennsylvania 15222		X		
Allied Chemical Corporation Plastics Division Post Office Box 2365R Morristown, New Jersey 07960				
Allied Fluid Components Corporation 35-51 41st Street Long Island City, New York 11101				
Allis-Chalmers Corporation Industrial Tractor Division Post Office Box 521 Topeka, Kansas 66601				
Ali Steel Pipe and Tube, Incorporated 145 Weldon Parkway Maryland Heights, Missouri 63042				
Almac Plastics, Incorporated 47-42A 37th Street Long Island City, New York 11101				
Alon Processing, Incorporated Grantham Street Tarentum, Pennsylvania 15084		X		
Alro Plumbing Specialty Company, Incorporated 396 Flushing Avenue Brooklyn, New York 11205				
Alside, Incorporated 3769 Akron-Cleveland Road Akron, Ohio 44309				
Aluminum Alloys Corporation 390 Plantome Road Manhasset, New York 11030				
Aluminum Company of America 1226 Alcoa Building Pittsburgh, Pennsylvania 15219		X		X
Aluminum Mill Supply Corporation Frankton Street and Hook Creek Valley Stream, New York 11582				



	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used In Concepts</u>
Aluminum Shapes, Incorporated 9014 River Road Delair, New Jersey 08110				
American Bridge Division United States Steel Sixth and Grant Streets Pittsburgh, Pennsylvania 15219		X		
American Cast Iron Pipe Company American Steel Pipe Division Post Office Box 2727 Birmingham, Alabama 35202		X	X	
American Fiberglass Fabricators, Incorporated 3000 Winding Waters Lane Elkhart, Indiana 46514		X		
American Gilsonite Company 1150 Kennecott Building Salt Lake City, Utah 84111		X		
American Hoechst Corporation Route 202-206 North Somerville, New Jersey 08876				
American Polymers, Incorporated 50 California Avenue Patterson, New Jersey 07510				
American Tractor Equipment Company 9131 San Leandro Street Oakland, California 94604		X		
Ameron 400 South Atlantic Boulevard Monterey Park, California 91754				
Ames-Frey Company 1430 Adalia Street Post Office Box 3177 South El Monte, California 91733		X		

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Amcco Chemicals Corporation Industrial Products Division 1530 Commerce Drive Stow, Ohio 44224				
Ampco Metal Division Ampco-Pittsburgh Corporation 38th and Maple Street Milwaukee, Wisconsin 53201		X		
Anaconda American Brass Company 414 Meadows Street Waterbury, Connecticut 06720		X		
Anchor Plastics Company, Incorporated 36-35 Thirty-fifth Street Long Island City, New York 11106				
An-Cor Industrial Plastics, Incorporated 388 Sweeney Tr. North Tonawanda, New York 14120		X	X	
Andonian Cryogenics, Incorporated 28 Farwell Street Newtonville, Massachusetts 02160		X		
Andrews Industries, Incorporated Route 130 Dayton, New Jersey 08810		X	X	X
Ano-Coil Corporation 60 East Main Street Rockville, Connecticut 06066				
Anvil Products, Incorporated 31 Lamond Street Allison Park, Pennsylvania 15101				
Apex Fibreglass Products Division 100 Elm at Washington Street Cleveland, Ohio 44113		X		
Applied Plastics Company, Incorporated 403 South 6th Street Milwaukee, Wisconsin 53204				
Arby Construction, Incorporated 14901 West National Avenue New Berlin, Wisconsin 53151				

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Arco/Polymers, Incorporated 1500 Market Street Philadelphia, Pennsylvania 19101				
Argo Plastics Products Corporation 2433 East 75th Street Cleveland, Ohio 44104	X			
Argus Chemical Corporation Subs. of Witco Chemical Corporation 633 Court Street Brooklyn, New York 11231				
Armco Steel Corporation Post Office Box 600 Middletown, Ohio 45042		X	X	X
Arrow Industries, Incorporated 44 East 8th Avenue Midvale, Utah 84047				
Arrow Tank Company, Incorporated Continental Pipe Manufacturing Company, Incorporated 20 Barnett Street Buffalo, New York 14215		X		
ASC Industries, Incorporated 6938 West Goshen Avenue Visalia, California 93227				
ASC Plastics, Incorporated North 810 Fancher Way Spokane, Washington 99206		X	X	X
Ashland Oil, Incorporated 1409 Winchester Avenue Ashland, Kentucky 41101				
Associated Pile and Fitting Corporation 202 Rutherford Boulevard Clifton, New Jersey 07014		X		
Associated Plastic Fabricators, Incorporated 222 Hintz Road Wheeling, Illinois 60090				
Astro-Arc Company 11144 Penrose Street Sun Valley, California 91352		X	X	X

<u>Returned</u>	<u>Reply</u>	<u>Useful</u>	<u>Use</u>
<u>By USPS</u>	<u>Received</u>	<u>Information</u>	<u>Con</u>

Astubeco, Incorporated  
73 George Road  
Edgewater, New Jersey 07020

Atlantic Pipe Bending and Fabricating Corporation  
Post Office Box 261  
Montvale, New Jersey 07645

Atlantic Pipe Corporation  
60 North Washington Street  
Plainville, Connecticut 06062

Atlas Corporation (Titeflex)  
603 Hendee Street  
Springfield, Massachusetts 01109

X

Atlas Plastics, Incorporated  
77-T Dingens Street  
Buffalo, New York 14206

Aztec Products, Incorporated  
468-T Paterson Avenue  
East Rutherford, New Jersey 07073

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Babcock and Wilcox Company 161 East 42nd Street New York, New York 10017		X	X	
Badall Company, Incorporated 4904 Calumet Boulevard Hammond, Indiana 46320		X	X	
Badger Aluminum Extrusions 960 Georgia Avenue Brooklyn, New York 11207				
Bancroft, H. S. Corporation 2 Rockhill Industrial Park Cherry Hill, New Jersey 08003				
Barber-Greene Company 400 North Highland Avenue Aurora, Illinois 60507				
Barrows Corporation Langdon and Wiehe Roads Cincinnati, Ohio 45237				
Bart Manufacturing Company 126 Manchester Place Newark, New Jersey 07104	X			
Bassett Steel and Tube Company Post Office Box 40 King of Prussia, Pennsylvania 19406		X		
Baxter Rubber Company 10 Spielman Road Fairfield, New Jersey 07006				
B. C. Pump and Engineering, Incorporated RFD 2, Box 655 Merritt Island, Florida 32952				
Beall Pipe and Tank Corporation 12005 North Burgard Portland, Oregon 97203		X	X	
Beetle Plastics, Incorporated Post Office Box 1123 Dayton, Ohio 45401		X	X	X
Belmont Smelting and Refining Works, Incorporated 320 Belmont Avenue Brooklyn, New York 11207		X		
Beloit Pipeline Construction, Incorporated Route 1, Highway 51 South Beloit, Illinois 61080				

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Beltran Associates, Incorporated 1141 East 35th Street Brooklyn, New York 11210		X		
Bergen Point Fabricators, Incorporated 213 West 5th Street Bayonne, New Jersey 07002				
Berger Industries, Incorporated 74-16T Grand Avenue Maspeth, New York 11378				
Bernard Pipeline Company, Incorporated Post Office Box 8176 Akron, Ohio 44320				
Bethlehem Steel Corporation Bethlehem, Pennsylvania 18016				
Bethlehem Steel Corporation Supply Division 16 West Sixth Street Post Office Box 2171 Tulsa, Oklahoma 74119		X		
Bieler National Industries 45-T Gilpin Avenue Hauppauge, New York 11787				
Birmingham Tank Company 621 Fourth Avenue, South Birmingham, Alabama 35233				
Bishopic Products Company 4413 Kings Run Drive Cincinnati, Ohio 45232				
Bittner Industries, Incorporated Post Office Box 10265 Mobile, Alabama 35810				
Blanchard Industries, Incorporated 179-T Main Street West Orange, New Jersey 07052		X		
Blickman, S., Incorporated 526 Gregory Avenue Weehawken, New Jersey 07087				
Blum, Julius and Company, Incorporated Off Highway 17 Carlstadt, New Jersey 07072		X		

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used In Concepts</u>
Boiler Tube Company of America Boyd Building McKees Rocks, Pennsylvania 15136		X		
Bond Brothers, Incorporated 145 Spring Street Post Office Box 26 Everett, Massachusetts 02149				
Bonded Fibre Glass Company 201-203 19th Street Union City, New Jersey 07087				
Boothe Engineering Company Post Office Box 97T Tonawanda, New York 14150		X		
Borden Chemical Company Division of Borden 511 Lancaster Street Leominster, Massachusetts 01453		X		
Borg-Warner Chemicals - Plastics Post Office Box 68 Washington, West Virginia 26181				
Bowerston Shale Company Post Office Box 199 Bowerston, Ohio 44695		X		
Bradco, Incorporated Post Office Box 266 Delhi, Iowa 52223				
Brass-Craft Manufacturing Company 618 Fisher Building Detroit, Michigan 48202		X		
Briggs Rubber Products Company Post Office Box 2657 Wilmington, Delaware 19805				
Brown Boiler and Tank Works, Limited 1052 Brown Street Franklin, Pennsylvania 16323				
Brown, Roscoe, Sales Company, Incorporated Route 1 Lenox, Iowa 50851		X		
Brown Strauss Corporation 14th and Osage Streets Kansas City, Kansas 66119		X		

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Brucar Equipment and Supply Company, Incorporated 300 Babylon Turnpike Roosevelt, New York 11575		X		
Brunswick One Brunswick Place Skokie, Illinois 60076		X	X	X
Buffalo Tank Division Bethlehem Steel Corporation South Avenue Punellen, New Jersey 08812		X		
Builders Structural Steel Corporation 11103 Memphis Avenue Cleveland, Ohio 44144	X			
Bunnell Plastics, Incorporated Interstate 295 and Harmony Road Mickleton, New Jersey 08056				
Busada Manufacturing Corporation 327 New South Road Hicksville, New York 11801				



<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
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Cadillac Plastic and Chemical Company  
15113 Second Avenue  
Detroit, Michigan 48226

Cal-Metal Corporation  
1351 West Sepulveda Boulevard  
Torrance, California 90509

X

Camden Alloy Fabricators  
560-600 South 2nd Street  
Camden, New Jersey 08103

Cameron Iron Works, Incorporated  
Post Office Box 1212-TR  
Houston, Texas 77001

X

Canron, Incorporated  
Warren Pipe Division  
183 Sitgreaves Street  
Phillipsburg, New Jersey 08865

Can-Tex Industries  
Post Office Box 340  
Mineral Wells, Texas 76067

X

Capitol Manufacturing Company  
155 West Fulton Street  
Columbus, Ohio 43215

X

Capitol Pipe and Steel Products, Incorporated  
301 City Line Avenue  
Bala Cynwyd, Pennsylvania 19004

Capitol Products Corporation  
Box 69  
Mechanicsburg, Pennsylvania 17055

Cardinal Chemical Company  
2010 South Beltline Boulevard  
Columbia, South Carolina 29201

Cardinal Products, Incorporated  
3707 Rawlins  
Dallas, Texas 75219

Carlson, An Indian Head Company  
3 Commerce Park Square  
23200 Chagrin Bouievard  
Cleveland, Ohio 44122

Carlson Thermo Plastics, Incorporated  
7645 Logans  
Minneapolis, Minnesota 55423

<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
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Carolina Aluminum Company  
Winton, North Carolina 27986

Carolina Culvert Manufacturing, Incorporated  
Post Office Box 1388  
Highway 401, South  
Raleigh, North Carolina 27602

X

Caterpillar Tractor Company  
100 Northeast Adams  
Peoria, Illinois 61602

Cavalon Plastics Company  
Post Office Box 384  
Winchester Industrial Park  
Winchester, Virginia 22601

Cell Cote Company  
142 Sheldon Road  
Berea, Ohio 44017

X

Celanese Corporation  
Department 563  
522 Fifth Avenue  
New York, New York 10036

Celanese Piping Systems, Incorporated  
2931 West Magazine Street  
Louisville, Kentucky 40202

X

Celanese Piping Systems  
4300 Cemetery Road  
Hilliard, Ohio 43026

Cement Asbestos Products Company  
2144 Highland Avenue, South  
Birmingham, Alabama 35205

X

Central Bergen Supply Company  
52 State Street  
Hackensack, New Jersey 07602

Central Engineering and Supply Company  
834-T Main Avenue  
Passaic, New Jersey 07055

Central Foundry Company  
90 Park Avenue  
Suite 918  
New York, New York 10016

X

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Centrifugal Products, Incorporated 3245 Cherry Avenue Long Beach, California 90807		X		
Century Fiberglass, Incorporated 1145 Red Gum Street Anaheim, California 92806		X	X	X
Ceramic Coating Company Post Office Box 370-T Newport, Kentucky 41072				
Certain-Teed Products Corporation Pipe and Plastics Group Valley Forge, Pennsylvania 19481		X	X	X
Charlotte Pipe and Foundry Company 2109 Randolph Road Post Office Box 4430 Charlotte, North Carolina 28204		X		
Chemical Coatings and Engineering Company, Incorporated Brook Road and Baltimore Pike Media, Pennsylvania 19063				
Chemical Equipment Corporation 7454 East 46th Street Tulsa, Oklahoma 74145				
Chemical Proof Corporation 19205 144th Northeast Woodinville, Washington 98072		X	X	
Chicago Pneumatic Equipment Company Orchard and Howard Streets Franklin, Pennsylvania 16323				
Chicago Tube and Iron Company 2528 West 48th Street Chicago, Illinois 60632				
Chromalloy American Corporation 120 Broadway New York, New York 10006	X			

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used In Concepts</u>
Cincinnati Milacron 4165 Halfacre Road Batavia, Ohio 45103				
Cincinnati Milacron Chemicals, Incorporated West Street Reading, Ohio 45215				
Clark Loy, Pipeline Company 3805 Southwest 141st Avenue Beaverton, Oregon 97005				
Cleveland Trencher Company Division American Hoist and Derrick Company 63 South Robert Street St. Paul, Minnesota 55107		X		
Clow Corporation 1211 West 22nd Street Oak Brook, Illinois 60521		X	X	X
Coast Marine Associates, Incorporated 280-B Route 46 Dover, New Jersey 07801				
Coch Oil Company 4111 East 37, North Wichita, Kansas 67220				
Collins Pipe, Incorporated 8300 Baldwin Oaklawn, California 94621	X			
Conley Corporation 91st and South Delaware Department T Tulsa, Oklahoma 74105		X	X	X
Conoco Chemicals Division of Continental Oil Company Park 80 Plaza East Saddle Brook, New Jersey 07662				
Consolidated Metals Corporation 1 Hicks Avenue Newton, New Jersey 07860				
Consolidated Pipe and Tube Company Post Office Box 191 San Angelo, Texas 76901				
Continental Boiler Works, Incorporated 5603 West Park Avenue St. Louis, Missouri 63110		X		

<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
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Continental Industries, Incorporated  
4102 South 74th East Avenue  
Post Office Box 994  
Tulsa, Oklahoma 74101

Continental Plastics Industries, Incorporated  
1300 40th Street  
Denver, Colorado 80205

Conwed Corporation  
Tech Center  
2200 Highcrest Road  
St. Paul, Minnesota 55113

Cook, M. H., Pipeline Construction Company  
Post Office Box 16146  
Salt Lake City, Utah 84116

Coolsaet, R. L., Construction Company  
Post Office Box 279  
Romulus, Michigan 48174

Cooneys Pipe and Copper Works, Incorporated  
Post Office Box 306  
Wilmington, California 90744

X

Corban Industries  
Post Office Box 5737  
1800 Knox Road  
Tampa, Florida 33605

Corgi Products  
1213 East 33rd and Schaeffer  
Cleveland, Ohio 44114

Cornell and Underhill, Incorporated  
1302 Jefferson Street  
Hoboken, New Jersey 07030

Corofac, Incorporated  
4492 Orchard Street  
Mantua, Ohio 44255

Cor-Pipe Corporation  
455 Jarvis Avenue  
Des Plaines, Illinois 60018

X

X

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Corrosion Treatment Corporation  
1100 Burt Street  
Byesville, Ohio 43723

Corr Tech, Incorporated  
11569 Goodright Lane  
Dallas, Texas 75229

X

Couse and Bolten Company  
40 Lafayette Street  
Newark, New Jersey 07102

Coventry Manufacturing Company, Incorporated  
149 East 3rd Street  
Mount Vernon, New York 10550

Craftsmen Welders, Incorporated  
518 Columbia Street  
Brooklyn, New York 1231

Crescent Machine and Nipple Company  
1950 Mallia Road  
Allegan, Michigan 49010

X

Cresline Plastic Pipe Company  
955 Diamor... Avenue  
Evansville, Indiana 47717

Crest Bending, Incorporated  
432 East Main  
Crestline, Ohio 44821

X

Cretex Companies, Incorporated  
(Cretex Plastics - Minneapolis)  
311 Lowell Avenue  
Elk River, Minnesota 55330

X

X

Crispin Company  
22 World Trade Center  
Houston, Texas 77002

Crown Line Plastics, Incorporated  
Post Office Box 1197, Department A  
Nebraska, City, Nebraska 68410

Crystal-X Corporation  
Pine and Second Streets  
Darby, Pennsylvania 19023

X

Cumberland Engineering Company, Incorporated  
Post Office Box 6065  
Providence, Rhode Island 02904

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Cupples Coiled Pipe  
Post Office Box 3436  
Austin, Texas 78704

Curran, Michael, and Associates  
1805 South Bellaire Street, Suite 500  
Denver, Colorado 80222

Curtiss-Wright Corporation  
Buffalo Facility  
58 Grider Street  
Buffalo, New York 14215

X

Custom Extruders, Incorporated  
50 East Carmans Road  
Farmingdale, New York 11735

Cylops Corporation  
650 Washington Road  
Pittsburgh, Pennsylvania 15228

X

<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concept</u>
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Dallas-Jetco, Incorporated  
3550 East Main  
Grand Prairie, Texas 75050

Dason Stainless Products Company, Incorporated  
West Grand and Elisabeth Avenue  
Rahway, New Jersey 07065

Davidson Pipe Supply Company, Incorporated  
2nd Avenue at 50th Street  
Brooklyn, New York 11232

Davis Manufacturing  
Division of J. E. Case/A Tenneco Company  
Post Office Box 1801  
Wichita, Kansas 67201

X

Davis-Standard/Goulding  
U. S. Route 1  
Pawcatuck, Connecticut 02891

Dearman Manufacturing Products, Incorporated X  
2104 Lapeer Road  
Flint, Michigan 48503

DeBell and Richardson, Incorporated  
Water Street  
Enfield, Connecticut 06082

Decker Manufacturing Corporation  
1938 Clark Street  
Aubion, Michigan 49224

Delta Pipeline Constructors, Incorporated  
6731 Gilmore Road  
Fairfield, Ohio 45014

Demaco Industries, Incorporated  
Wolferz Alloy Division  
15 Park Street  
Belleville, New Jersey 07109

Denier, James C., Company  
Post Office Box 56-T  
3686 Poole Road  
Cincinnati, Ohio 45239

X

Dent Manufacturing, Incorporated  
Box T, 226 West 27th Street  
Northampton, Pennsylvania 18067



	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Depew Manufacturing Corporation 60 Duffy Avenue Hicksville, New York 11801				
DeWitt Rubber Manufacturing Company 10 Plough Road Fairfield, New Jersey 07006		X		
Diamond Aluminum Company 333 West 5th Street Cincinnati, Ohio 45202				
Diamond Shamrock Chemical Company 1100 Superior Avenue Cleveland, Ohio 44114				
Diesel Chemicals and Metals Company, Incorporated 599 Sackett Street Brooklyn, New York 11217		X		
Dimetrics 11245 Van Owen Street North Hollywood, California 91605		X	X	X
Distribution Construction Company Post Office Box 45570 Tulsa, Oklahoma 74145				
Ditch Witch Division Charles Machine Works Post Office Box 66 Perry, Oklahoma 73077		X		
Ditch Witch of Wisconsin Post Office Box 188 Big Bend, Wisconsin 53103				
Division Lead Company 7767 West 61st Place Summit, Illinois 60501				
Dixie Plastics Manufacturing Company 4250 Florida Avenue Post Office Box 52769 New Orleans, Louisiana 70117		X		
Dixie Tube and Steel, Incorporated Dothan, Alabama 36301	X			

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concept</u>
Donaldson Construction Company, Incorporated Post Office Box 465 Dodge Center, Minnesota 55927				
Donley Pipe and Supply Company 3324 North Broadway St. Louis, Missouri 63160				
Donnelly and Burns Associates 5 Riggs Avenue Severna Park, Maryland 21146		X		
Dover Corporation OPW Division 2735 Colerain Avenue Cincinnati, Ohio 45225		X	X	X
Dow Chemical USA Plastics Lined Piping Products 2020 Dow Center Midland, Michigan 48640				
Dowell Division 1579 East 21st Tulsa, Oklahoma 74114		X		
Dravo Corporation 1800 One Oliver Plaza Pittsburgh, Pennsylvania 15222				
Druid Plastics, Incorporated 4-T Great Meadow Lane East Hanover, New Jersey 07936		X		
Ductile Iron Company of America Department A Carolan Street Post Office Box 2005 Savannah, Georgia 31402				
duPont, E. I., de Nemours and Company Talley Building - Concord Plaza Wilmington, Delaware 19898		X		
Dura-Line Corporation South Industrial Park Middlesboro, Kentucky 40965				
Durham Plastics, Incorporated 1264 West Sharon Road Cincinnati, Ohio 45218				

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used In Concepts</u>
Eastman Chemical Products, Incorporated Post Office Box 431 Kingsport, Tennessee 37662				
Eastmond, A. L., and Sons, Incorporated 308 West 143rd Street New York, New York 10030				
Eatherly, Incorporated Post Office Box 756 Garden City, Kansas 67846				
Emco Industries, Incorporated Post Office Box 864 Des Moines, Iowa 50304		X		
Emery Company, Incorporated 11411 Bradley Avenue Pacolma, California 91331				
Empire-Detroit Steel Division Detroit Steel Corporation, Cyclops Corporation Dover, Ohio 44622		X		
Ervite Corporation 4010 West Ridge Road Erie, Pennsylvania 16505				
Esco Corporation 2171 Northwest 25th Avenue Portland, Oregon 97210				
Ethyl Corporation Polymer Division 451 Florida Avenue, Ethyl Tower Baton Rouge, Louisiana 70801		X	X	X
Ethylene Corporation 755 Central Avenue Murray Hill, New Jersey 07974		X	X	
Evans Pipeline Equipment Company Box 347 Broken Arrow, Oklahoma 74012				
Extruded Plastics Company, Incorporated Post Office Box 15167 Santa Ana, California 92705				

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By USPS

Reply  
Received

Useful  
Information

Used In  
Concepts

Extrusion Control Technology, Incorporated  
123 West Padre Street - Suite G  
Santa Barbara, California 93105

X

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used In Concepts</u>
Fab-Alloy Company 1163 Bridge Street Jackson, Michigan 49203		X		
Fabick, John, Tractor Company One Fabick Drive Fenton, Missouri 63026				
Fansteel, Incorporated Number One Tantalum Place North Chicago, Illinois 60064		X		
Federal-Mogul Corporation Industrial Sales Post Office Box 1966 Detroit, Michigan 48235				
Fellows Corporation Post Office Box 399 Springfield, Vermont 05156				
Fibercast Corporation Box 968 Sand Springs, Oklahoma 74063		X	X	X
Fiberglass Industrial Products 10497 Main Mantua, Ohio 44255		X	X	
Fiberglass Resources Corporation Motor Avenue, Northeast Farmingdale, New York 11735		X	X	X
Fiberglass Structures 733 South 10th Richmond, California 94804				
Fibre-Res Products, Incorporated Iola, Kansas 66749	X			
Filtronics, Limited 184-188 Monhagen Avenue Middletown, New York 10940		X		
Flagg, C. N., and Company, Incorporated 405 Murdock Avenue Meriden, Connecticut 06450				
Fletcher-Brady, Incorporated 9 Hendricks Avenue Cheshamhurst, New Jersey 08089				

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Flex Plastics, Incorporated 16215 Brookpark Road Cleveland, Ohio 44135				
Flex-Weld, Incorporated 221 Main Street Bartlett, Illinois 60103		X		
Flintkote Company Pipe Products Division One Cascade Plaza Akron, Ohio 44308		X		
Flonetics, Incorporated Box 216 King of Prussia, Pennsylvania 19406				
Fluorodynamics, Incorporated 2 Diamond State Industrial Pike Newark, Delaware 19711				
Ford, Bacon and Davis Construction Corporation Post Office Box 1762 Monroe, Louisiana 71201				
Ford Motor Company Ford Division, Fleet and Leasing Sales Post Office Box 1530 Dearborn, Michigan 48121				
Formed Tubes, Incorporated Post Office Box 129 Sturgis, Michigan 49091		X		
Forney's, Incorporated Route 18, R.D. 2 Wampum, Pennsylvania 16157				
Forni, Jay, Incorporated 1887-A Arnold Industrial Highway Concord, California 94520		X		
Fort Worth Pipe and Supply 2010 East Lancaster Fort Worth, Texas 76101				
Foster, L. B. Company 600-Seven Parkway Center Pittsburgh, Pennsylvania 15220				
Four D Manufacturing Company Glenville, West Virginia 26351				

<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
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Franklin Fibre-Lamitex Corporation  
North East Boulevard and East 13th Street  
Wilmington, Delaware 19802

X

Frasse, Peter A., and Company, Incorporated  
3 Dakota Avenue  
Lake Success, New York 11040

Fromson Company, Incorporated  
60 East Main  
Rockville, Connecticut 06066

Futura Titanium Corporation  
31166 Via Colinas  
Westlake Village, California 91361

X

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used In Concepts</u>
Gabe's Construction Company, Incorporated Post Office Box 385 Sheboygan, Wisconsin 53081				
Gamah Post Office Box 20308 Denver, Colorado 80220		X	X	X
Garrigan, M. B., Company Omega Alloy Division 111 Gotthart Street Newark, New Jersey 07105				
Garzel Plastics Industries, Incorporated 15902 East 32 Mile Road Romeo, Michigan 48065				
Gas Construction Company, Incorporated 82 Stokes Avenue Trenton, New Jersey 08638				
Gas Lines, Incorporated Post Office 233 Charlotte, North Carolina 28230				
Gaspro, Incorporated 2305-2371 Dillingham Boulevard Post Office Box 2454 Honolulu, Hawaii 96804				
Gatto Machinery 45 Rabrow Drive Hauppauge, New York 11787		X		
Gaycraft Plastics, Incorporated 1200 Grand Avenue Schofield, Wisconsin 54476				
General Aerospace Materials Corporation 95-TE Bethpage Road Plainview, New York 11803		X		
General Electric Company Plastics Department Noryl Avenue Selkirk, New York 12158				
General Malleable Company 124 Sidney Street St. Louis, Missouri 63166				
General Rubber Corporation 111 Empire Boulevard South Hackensack, New Jersey 07606		X		



<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used Conce</u>
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General Steel Tank Company, Incorporated  
4020 Eighth Avenue, North  
Birmingham, Alabama 35203

Generation Metals Corporation  
300 Oser Avenue  
Hauppauge, New York 11787

G.E.T. Construction, Incorporated  
West 229, North 2480 Highway 164  
Waukesha, Wisconsin 53186

Gerhardt, George T., Company, Incorporated  
Post Office Box 96  
Sausalito, California 94965

X

Gibbs/Cook  
Post Office Box 936  
Des Moines, Iowa 50304

Giberson, E. D., and Company, Incorporated  
58-00 57th Street  
Maspeth, New York 11378

X

Gifford-Hill and Company, Incorporated  
8435 Stemmons Freeway  
Dallas, Texas 75247

Glamorgan Pipe and Foundry Company, Incorporated  
Lynchburg, Virginia 24505

X

Glasco Equipment Corporation  
6 Wait Street  
Patterson, New Jersey 07524

Glassstrand/IDSI Products, Incorporated  
342 Robinson Street  
North Tonawanda, New York 14120

Glastronics Corporation  
100 Industrial Park  
New Bedford, Massachusetts 02745

X

Goodall Rubber Company  
Whitehead Road  
Trenton, New Jersey 08604

Goodrich, B. F., Chemical Company  
6100 Oak Tree Boulevard  
Cleveland, Ohio 44131

<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
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Goodyear Tire and Rubber Company  
Plastics Department  
5408 Baker Avenue  
Niagara Falls, New York 14304

Gray, J. S., Company, Incorporated  
Post Office Box 2994  
Richmond, Virginia 23235

X

Great Lakes Plastic Company, Incorporated  
2373 Broadway Terrace  
Buffalo, New York 14212

Green Point Pipe Supply Corporation  
342 Stagg Street  
Brooklyn, New York 11206

Greene Rubber Company, Incorporated  
162 Second Street  
Cambridge, Massachusetts 02142

Greenspun Brothers  
Pipe and Supply Company  
National Stock Yards, Illinois 62071

Grewe-Plastics  
125 South 15th Street  
Newark, New Jersey 07107

Gulf Oil Company-U.S.  
Post Office Drawer 2100  
Houston, Texas 77001

Gulf and Western Manufacturing Company  
(Bonney Forge)  
Oak Brook, Illinois 60521

X

Guyon, Charles F., Incorporated  
522 Fifth Avenue  
New York, New York 10036

GZ Products, Incorporated  
2400-01 Bold River Road  
Rancho Cordova, California 95670

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Hallen Construction Company, Incorporated 4270 Austin Boulevard Island Park, New York 11558				
Hames Construction and Equipment Company, Incorporated 11333 South Avenue North Lima, Ohio 44452				
Hammond Valve Corporation 1844 Summer Street Hammond, Indiana 46320		X		
Hancock Gross Company 401 North 21st Street Philadelphia, Pennsylvania 19103				
Handy and Herman 850 Third Avenue New York, New York 10022		X		
Harlan Agents and Brokers, Incorporated 5155 East 51st Street Tulsa, Oklahoma 74135				
Harris Thermal Transfer Products, Incorporated X 62 Southeast Yamhill Street Portland, Oregon 97214				
Hart Engineering Company 301 Wampanoag Trail East Providence, Rhode Island 02914				
Harvel Plastics, Incorporated Post Office Box 757-T Easton, Pennsylvania 18042		X	X	
Hasbrouck Plastics, Incorporated 1977 Lakeview Road Hamburg, New York 14075		X		
Haveg Industries, Incorporated 900 Greenbank Road Wilmington, Delaware 19808		X	X	
Hell Process Equipment Corporation 12950 Elmwood Avenue Cleveland, Ohio 44111				
Henkels and McCoy, Incorporated Jolly Road Blue Bell, Pennsylvania 19422				

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Hibben and Company  
9376 South Ewing Avenue  
Chicago, Illinois 60617

X

Kimmel Brothers Company  
1415 Dixwell Avenue  
Hamden, Connecticut 06514

Hobart Brothers Company  
600 West Main Street  
Troy, Ohio 45373

X

Hofmann Industries, Incorporated  
Shillington Road and Penn Avenue  
Sinking Spring, Pennsylvania 19608

X

Holloway and Hunn, Incorporated  
1379 Wasdale Avenue  
Elk Grove Village, Illinois 60007

Hood Corporation  
8201 South Sorenson Avenue  
Post Office Box 4368  
Whitter, California 90607

Hooker Chemical Corporation  
Ruco Division  
Post Office Box 456 - River Road  
Burlington, New Jersey 08016

Horizontal Holes  
Division Boring and Tunneling Company of America  
Post Office Box 14214  
Houston, Texas 77021

H-P Products, Incorporated  
574 West Gargas Street  
Louisville (Canton Sub), Ohio 44641

Huntingdon Machine Division  
Gulf and Western Manufacturing Company  
Post Office Box 400  
Huntingdon, Pennsylvania 16652

X

Huntington Alloy Products Division  
The International Nickel Company, Incorporated  
Huntington, West Virginia 25720

Hurlbut Plastic Pipe Corporation  
206 East Olin Avenue  
Box 489  
Madison, Wisconsin 53701

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Hyaline Plastics Corporation  
1019 North Capitol Avenue  
Indianapolis, Indiana 46204

Icke Construction Company, Incorporated  
Post Office Box 4039  
Madison, Wisconsin 53711

IML Metals, Incorporated  
2065-T 5th Avenue  
Ronkonkoma, New York 11779

Indust Corporation  
2635 Kennedy Boulevard  
North Bergen, New Jersey 07047

Industrial Coatings, Incorporated  
7032 Quad Avenue  
Baltimore, Maryland 21237

Industrial Mechanical Contractors, Incorporated  
1401 North 33rd Street  
Texas City, Texas 77590

Industrial Pipe and Supply Company  
5106 West 16th Street  
Chicago, Illinois 60650

Industrial Plastic Fabricators, Incorporated  
56 Endicott Street  
Norwood, Massachusetts 02062

Industrial Polychemical Service  
17116 South Broadway  
Post Office Box 471  
Gardena, California 90247

X

X

Industrial Service Centers, Incorporated  
191 Chesapeake Park  
Baltimore, Maryland 21220

Inland-Ryerson Construction Products Company (INRYCO) X  
4101 West Burnham Street  
Milwaukee, Wisconsin 53201

Insley Manufacturing Corporation  
Post Office Box 11308  
Indianapolis, Indiana 46201

Interlake, Incorporated  
135th Street and Perry Avenue  
Department TR  
Chicago, Illinois 60627

X

International Boring Systems Company  
210 Parker Square Bank Building  
Wichita Falls, Texas 76308

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International Harvester Company  
Post Office Box 270  
Melrose Park, Illinois 60160

International Nickel Company, Incorporated  
One New York Plaza, Department T  
New York, New York 10004

X

International Pipe and Steel Supply Corporation  
710 North Post Oak, Ste. 306-T  
Houston, Texas 77024

International Trade Service, Incorporated  
Post Office Box 344-T  
Willingboro, New Jersey 08046

ITT Grinnell Corporation  
260 West Exchange Street  
Providence, Rhode Island 02920

ITT-Thermotech  
Plastic Components Division  
1205 South Fifth Street  
Hopkins, Minnesota 55343

X

<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used In Concepts</u>
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Jacobs, B & J, Company, Incorporated  
1732 John Street  
Cincinnati, Ohio 45214

Jakmas Plumbing & Heating, Incorporated  
4651 Oberlin Avenue  
Lorain, Ohio 44053

Jarl Extrusions, Incorporated  
Winding Street  
East Rochester, New York 14445

Jenks Metals  
6501 Northwest 77th Avenue  
Miami, Florida 33166

X

Jet Stream Plastics  
Post Office Box 190  
Siloam Springs, Arkansas 72761

X

X

J. L. Fabricating Corporation  
172 Beaver Brook Road  
Lincoln Park, New Jersey 07035

X

Jodge Plastics, Incorporated  
9901 Foster Avenue  
Brooklyn, New York 11236

Johns-Manville Company  
Post Office Box 1960  
Trenton, New Jersey 08607

X

X

X

Johnson Metal Hose, Incorporated  
80 Sharon Road  
Waterbury, Connecticut 06720

Johnson Plastics Machinery  
1600 Johnson Street  
Chippewa Falls, Wisconsin 54729

Johnson Products Vinylife Hose Division  
23591 Van Born Road  
Taylor, Michigan 48180

X

Johnson, R. W., Company, Incorporated  
2550 South Garnsey  
Santa Ana, California 92707

Jones and Hunt, Incorporated  
75 Pheasant Run Road  
Orwigsburg, Pennsylvania 17961

Jones and Laughlin Steel Corporation  
3A Gateway Center  
Pittsburgh, Pennsylvania 15230

X

X



	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used In Concept</u>
Joslyn Reinforced Plastics Division 5443 West Roosevelt Road Chicago, Illinois 60650		X		
Justin Enterprises, Incorporated 2933-T Symmes Road Fairfield, Ohio 45014		X		

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Kaiser Steel Corporation 2379 Kaiser Center 300 Lakeside Drive Oakland, California 94604		X		
Kearney Fluid Equipment, Incorporated 2624 Hamilton Boulevard South Plainfield, New Jersey 07080				
Kee Klamps North America, Limited Gascolgne Industrial Products, Limited 77 Benbro Drive Buffalo, New York 14225		X		
Keegan Utility Contractors, Incorporated 3830 Monroe Avenue Pittsford, New York 14534				
Keflex, Incorporated 225 Main Street Bartlett, Illinois 60103		X		
Kellog, M. W., Company 14433 South Paramount Boulevard Paramount, California 90723				
Kelley, O. G., Corporation 105 Taylor Boston, Massachusetts 02122	X			
Kenalmar Engineering, Incorporated 415 East Hudson Street Royal Oak, Michigan 48067				
Kendall Company Polyken Division 20 Walnut Street Wellesley Hills, Massachusetts 02181				
Kenway Corporation South Liberty Road Palermo, Maine 04354				
Kerona, Incorporated 2547 West Jackson Phoenix, Arizona 85009				
Kerona Plastic Extrusion Company 2050 East Fremont Stockton, California 95205				
Keystone Tubular Service Corporation East Cunningham and Cliff Streets Butler, Pennsylvania 16001				

<u>Returned</u> <u>By USPS</u>	<u>Reply</u> <u>Received</u>	<u>Useful</u> <u>Information</u>	<u>Used</u> <u>Concept</u>
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Kiely, J. F., Construction Company  
700 McClellan Street  
Long Branch, New Jersey 07740

King Brothers, Incorporated  
3520 Southeast 17th Avenue  
Portland, Oregon 97242

Kirk and Blum Manufacturing Company  
3186 Forrer Street  
Cincinnati, Ohio 45209

Kirkhill Rubber Company  
Cypress Court  
Brea, California 92621

X

KLM Metals Company  
41-T North Mall  
Plainview, New York 11803

X

K-Mac Plastics, Incorporated  
4477 Tallmadge Road  
Rootstown, Ohio 44272

X

Knight, Maurice A., Company  
171 Kelly Avenue  
Akron, Ohio 44309

X

Koch Fiberglass Products Company  
2501 South West Street  
Wichita, Kansas 67217

X

X

X

Kroy Metal Products Company, Incorporated  
Route 1  
York, Nebraska 68467

Kyova Pipe Company  
Division of Ashland Oil Company  
Post Office Box 2219  
Columbus, Ohio 43216

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concept</u>
LaBarge, Incorporated Tubular Division 7501 South Broadway St. Louis, Missouri 63111		X		
La Favorite Rubber Manufacturing Company 255 Wagaraw Road Hawthorne, New Jersey 07507		X		
Lake Chemical Company 270 North Washtenaw Avenue Chicago, Illinois 60612		X		
Lake Erie Welding and Fabricating, Incorporated 524 Ogontz Street Sandusky, Ohio 44870				
Lane Distributing Corporation Foot of Cropsey Avenue Brooklyn, New York 11224				
Lasco Industries, Incorporated Chapin Road and Lynch Street Montebello, California 90640		X		
Lasker, Harold, Company, Incorporated 536 Middle Neck Road Great Neck, New York 11023				
Latrobe Foundry Machine and Supply Company 203 Hillview Avenue Latrobe, Pennsylvania 15650		X		
Leland Equipment Company Post Office Box 45128 Tulsa, Oklahoma 74145				
Lenz Company 3305 Klepinger Road Dayton, Ohio 45401				
L & E Resleeving Company 1235 Southeast 29 Oklahoma City, Oklahoma 73129				
Leslie and Elliott Company East Railway and Iowa Avenue Paterson, New Jersey 07503				
Line-A-Corporation 326-T Frelinghuysen Avenue Newark, New Jersey 07114				

<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concept</u>
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Linehan Plastic Corporation  
2082 Irving Boulevard  
Dallas, Texas 75207

Linfor, Incorporated  
4930 West 35th Street  
Minneapolis, Minnesota 55416

X

Liquid Carbonic  
135 North LaSalle Street  
Chicago, Illinois 60603

Littleford Brothers, Incorporated  
4141 Airport Road  
Cincinnati, Ohio 45226

X

Logan Clay Products Company  
Post Office Box 698-T  
Logan, Ohio 43138

X

Lone Star Steel Company  
West Mockingbird Lane at Roper  
Dallas, Texas 75225

X

X

Luzerne Rubber and Plastics Company  
Post Office Box 987  
Taunton, Massachusetts 02780

Lyman, W. H., Construction Company  
433 South Vermont Street  
Palatine, Illinois 60067

Lynchburg Foundry Company  
58 Courtland Building  
Lynchburg, Virginia 28501

X

X

<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concept</u>
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McClarin Plastics, Incorporated  
Post Office Box 168-T  
Hanover, Pennsylvania 17331

McDonnell Aircraft Company  
Post Office Box 516  
St. Louis, Missouri 63166

X

X

X

McGregor-Michigan Corporation  
13360 Helen  
Detroit, Michigan 48212

X

McKay Contractors, Incorporated  
Post Office Box 66451 O'Hare Airport  
Chicago, Illinois 60666

McWane Cast Iron Pipe Company  
1201 Vanderbilt Road  
Post Office Box 607  
Birmingham, Alabama 35201

X

X

X

<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used In Concepts</u>
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Madsen and Howell, Incorporated  
505 Market Street  
Perth Amboy, New Jersey 08861

Magnatch  
Bradley Park  
East Grandby, Connecticut 06026

Mallinckrodt Chemical Works  
3600 North Second Street  
St. Louis, Missouri 63160

Maneely, John, Company  
Independence Square  
Public Ledger Building  
Philadelphia, Pennsylvania 19106

Manufacturers Rubber and Supply Company, Incorporated  
622 Union Avenue  
Memphis, Tennessee 38103

Marathon Steel Company  
1841 West Buchanan Street  
Phoenix, Arizona 85005

Mariners Company, Incorporated  
73 Gorge Road  
Edgewater, New Jersey 07020

Maritime Environment, Incorporated  
9 Grassy Plain Street  
Bethel, Connecticut 06801

Marquette Coppersmithing Company  
West Park Station  
Philadelphia, Pennsylvania 19131

X

Maryland Rubber Corporation  
1618-20 Edison Highway  
Baltimore, Maryland 21213

Massart Company  
Post Office Box 12788  
Seattle, Washington 98111

Master Tank and Welding  
1610 Singleton Boulevard  
Dallas, Texas 75212

Mathis Fiber Glass Coatings and  
Structures, Incorporated  
Denmark, South Carolina 29042

X

X

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Matthews, Jas. H. 6515 Penn Avenue Pittsburgh, Pennsylvania 15206		X		
Mead Pipe Alabama Post Office Box 309 Anniston, Alabama 36201		X		
Mercer Rubber Company 136 Mercer Street Trenton, New Jersey 08690		X		
Meridian Industries, Incorporated Prarie at Montague Street Sturgis, Michigan 49091				
Merrick Screw and Supply Corporation 1645T Stephen Street Brooklyn, New York 11227				
Metal Arts Company Post Office Box 14109-TR Houston, Texas 77021				
Metal Cladding, Incorporated Niagara and Erie R.R. (Buffalo) North Tonawanda, New York 14120		X		
Metals and Tubes Division Whittaker Corporation 6504 Hurst Houston, Texas 77008				
Metcon, Incorporated 1100 Easton Road Willow Grove, Pennsylvania 19090				
Metric and Multistandard Components Corporation 120 Old Saw Mill River Road Hawthorne, New York 10532		X		
Metropolitan Plumbing Supply Corporation 5000 Second Street Long Island City, New York 11101				
Metropolitan Valve Supply Company, Incorporated Maspeth Avenue and Olive Street Brooklyn, New York 11211				
Michels Pipe Line Construction, Incorporated Post Office Box 128 Brownsville, Wisconsin 53006				



<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concept</u>
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Michigan Trenching Service, Incorporated  
4033 East Morgan Road  
Post Office Box J  
Ypsilanti, Michigan 48197

Mid-American Industries, Incorporated  
Post Office Box 13224  
Riverside Station  
Memphis, Tennessee 38113

Midco Pipe and Tube, Incorporated  
Post Office Box 326  
Bensenville, Illinois 60106

Mid-Continent Pipeline Equipment Company  
Post Office Box 1551  
Houston, Texas 77001

X

Mid-Continent Supply Company  
Mid-Continent Building  
Fort Worth, Texas 76102

Mideast Aluminum Industries Corporation  
Post Office Box 248  
Dayton, New Jersey 08810

X

Midland Pipe and Supply Company  
6121 West 28th Street  
Cicero, Illinois 60650

Mid-Mountain Contractors, Incorporated  
Post Office Box 577  
Bellevue, Washington 98009

Midwesco-Enterprise, Incorporated  
1650 North Elston Avenue  
Chicago, Illinois 60622

Midwestern Contractors, Incorporated  
Post Office Box 706  
Wheaton, Illinois 60187

Midwestern Engine and Equipment Company  
Post Office Box 3445  
Tulsa, Oklahoma 74101

Miller Pipeline Corporation  
210 South Broadway  
Green Springs, Ohio 44836

X

X

Miller, Ray, Incorporated  
22 Fairfield Place  
West Caldwell, New Jersey 07006

<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used In Concepts</u>
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Mills Alloy Steel Company  
6 West Interstate Road  
Cleveland, Ohio 44146

Minalax Corporation  
Post Office Box 186  
White House Station, New Jersey 08889

Minnesota Limited, Incorporated  
390 County Road D  
St. Paul, Minnesota 55112

Minnotte Manufacturing Corporation  
1 Minnotte Square  
Pittsburgh, Pennsylvania 15220

Missouri Boiler and Tank Company  
2222 Papin Street  
St. Louis, Missouri 63103

M & M Hose Company  
9320 Mason  
Chatsworth, California 91311

Modern Constructors, Incorporated  
325 Lake Avenue, South  
Duluth, Minnesota 55802

Modern Plastics and Glass, Incorporated  
676 Howard Avenue  
Bridgeport, Connecticut 06605

Monsanto Polymers and Petrochemicals Company  
A Unit of Monsanto Company  
800 North Lindbergh Boulevard  
St. Louis, Missouri 63166

Montague Fisher, Incorporated  
Post Office Box 27218  
San Francisco, California 94127

Moore Manufacturing, Incorporated  
Industrial Way and Moore Road  
Brisbane, California 94005

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used In Concepts</u>
Moore, Samuel, and Company Industrial Park Mantua, Ohio 44255				
Morris-Young-Owens Company 12751 Main Street Houston, Texas 77035				
M P Industries, Incorporated 101 North Cool Springs Road C <sup>3</sup> Fallon, Missouri 63366		X		
M & Q Plastic Products 20 Bannard Street Freehold, New Jersey 07728				
M & T Chemicals, Incorporated Woodbridge Road and Randolph Avenue Rahway, New Jersey 07065		X		
Mueller Company 500 West Eldorado Street Decatur, Illinois 62525		X		
Mueller Pipeliners, Incorporated 2900 South 166th Street New Berlin, Wisconsin 53151				
Murray, A. E., Company, Incorporated Post Office Box 1000 Sharon, Massachusetts 02067				

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
National Annealing Box Company Braid Avenue and B & O Railroad Washington, Pennsylvania 15301				
National Fiberglass Products Corporation 7 Greenwood Avenue Romeoville, Illinois 60441				
National Fittings Company Post Office Box 503 St. Louis, Missouri 64166				
National Mine Service Company 3001 Koppers Building 436 7th Avenue Pittsburgh, Pennsylvania 15219		X		
National Plastifab, Incorporated 121 Muller Road Burlington, Massachusetts 01803				
National Tank and Pipe Company Post Office Box 17158 2301 North Columbia Boulevard Portland, Oregon 97217		X		
National Tube Forming, Incorporated 164 North Manning Hillsdale, Michigan 49242				
National Valve and Manufacturing Company 156 49th Street Pittsburgh, Pennsylvania 15201				
Natural Pipeline Company Box W Lakeville, Minnesota 55044				
Navco Plastic Pipe, Incorporated 1550 Elmwood Avenue Cranston, Rhode Island 02910				
Naylor Pipe Company 1231 East 92nd Street Chicago, Illinois 60619		X	X	X
Nebraska Plastics, Incorporated Post Office Box 45 Cozad, Nebraska 69130				

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Nelson Company  
B & O R.R. At Amos  
Holmes, Pennsylvania 19043

New England Lead Burning Company, Incorporated  
100 Baldwin Avenue  
North Woburn, Massachusetts 01801

New Jersey Aluminum Company, Incorporated  
Post Office Box 73T  
North Burnswick, New Jersey 08902

X

Niagra Polymer Products, Incorporated  
62 Skillen  
Buffalo, New York 14207

Non-Ferros International Corporation  
300 Park Avenue  
New York, New York 10022

Nooter Corporation  
1414 South Third Street  
St. Louis, Missouri 63166

X

Normandy Products Company  
1001 South Avenue  
Wilkinsburg, Pennsylvania 15221

North American Aluminum Corporation  
Naarco Square  
Kalamazoo, Michigan 49004

North Carolina Products Corporation  
632 Pershing Road  
North Raleigh Plant, North Carolina 27611

X

Northern Pipeline Construction Company  
Box 901, Highway 2 West  
Bemidji, Minnesota 56601

Northland Plastics, Incorporated  
1422 South 16th Street  
Sheboygan, Wisconsin 53081

Northwest Pipe and Casing Company  
9202 Southeast Lawnfield Road  
Clackamas, Oregon 97015

X

NRM Corporation  
47 West Exchange Street  
Akron, Ohio 44308

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Offenhauser Company  
Post Office Box 18068-TR  
Houston, Texas 77023

Ohio Pipe Bending and Coiling Company  
3890 Trent Avenue  
Cleveland, Ohio 44109

Ohio Pipe, Valves and Fittings, Incorporated  
3890 Trent Avenue  
Cleveland, Ohio 44109

Olin Evanite Plastics  
Carrollton, Ohio 44615

Olin Plastics  
120 Long Ridge Road  
Stamford, Connecticut 06904

Omega Alloy Division  
M. B. Garrigan Company  
111 Gotthart Street  
Newark, New Jersey 07105

O'Neal Steel, Incorporated  
747 North 41st Street  
Birmingham, Alabama 35202

Orban, Kurt, Company, Incorporated  
Two Orban Way  
Wayne, New Jersey 07470

X

Owens Corning Fiberglas Corporation  
Fiberglas Tower  
Toledo, Ohio 43659

Owens Corning Fiberglas Corporation  
5711 Sarvis Avenue  
Riverdale, Maryland 20840

X

Owens-Illinois, Incorporated  
Post Office Box 1035  
Department M.S.  
Toledo, Ohio 43666

X

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Pace Pipe Line Company Drawer B Delmont, Pennsylvania 15626				
Pacific Plastic Pipe Company Box 399 Beaverton, Oregon 97005				
Pacific States Cast Iron Pipe Company Post Office Box 1219 Provo, Utah 84601		X		
Pacific Western Extruded Products 9742 East Firestone Boulevard Downey, California 90241				
Pathway Bellows, Incorporated Department TR 1452 North Johnson Avenue El Cajon, California 92022		X		
PCM Company 1433-37 Ferry Street Camden, New Jersey 08104		X		
Peerless Plastics, Incorporated Post Office Box 956 Garden City, Kansas 67846				
Penn Galvanizing Company 2201 East Tioga Street Philadelphia, Pennsylvania 19134	X			
Pennsylvania Flexible Metallic Tubing Company Post Office Box 415-T Paoli, Pennsylvania 19301		X		
Perfection Corporation 640 North Lake Street Madison, Ohio 44057				
Perfection Sprinkler Company Box 1363-T Ann Arbor, Michigan 48106		X		
Perfex Plastics Division Rimer, Incorporated 2632 South Dearborn Street Chicago, Illinois 60616				
Perkasie Industries Corporation 54-55 Spruce Street Perkasie, Pennsylvania 18944		X		
Perma-Line Rubber Products Corporation 1735 North Winnebago Avenue Chicago, Illinois 60647				

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Perma-Rain Irrigation, Incorporated  
350 West Hermosa  
Lindsay, California 93247

Petrochemicals Company, Incorporated  
Post Office Box 2199  
Fort Worth, Texas 76101

Petroleum Pipe and Supply Company, Incorporated  
Hagood Building, Box 545  
Carnegie, Pennsylvania 15106

Phelps Dodge Copper Products Company  
300 Park Avenue  
New York, New York 10022

X

Phelps Packing and Rubber Company, Incorporated  
One Montgomery Road  
Baltimore, Maryland 21227

Phillips Products Company, Incorporated  
Plastic Pipe Division  
2655 Villa Creek Drive - Suite 155  
Dallas, Texas 75234

X

X

X

Phoenix Steel Corporation  
Claymont, Delaware 19703

Pierce-Roberts Rubber Company  
1400 Heath Avenue  
Trenton, New Jersey 08638

X

Pilot Manufacturing Corporation  
Post Office Box 3128  
20433 Earl Street  
Torrance, California 90510

Pipe Benders, Incorporated  
Post Office Box 396  
Duluth, Minnesota 55801

X

Pipe Fittings, Incorporated  
1000 North Main Street  
Wellington, Ohio 44090

Pipe Heating Systems, Incorporated  
A Subsidiary of Ric-Wil, Incorporated  
10101 Brecksville Road  
Brecksville, Ohio 44141

Pipe Lining and Coating Company  
15-06 129th  
College Point, New York 11356



	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used In Concepts</u>
Pipe Specialists, Incorporated Post Office Box 4368-T Boulder, Colorado 80302				
Pipeline Inspection Company, Incorporated 1919 Antoine Houston, Texas 77055		X		
Piping Engineering Company, Incorporated 8939 West 21st Street Sand Springs, Oklahoma 74063		X		
Piping Insulators, Incorporated 10 Osage Road Canton, Massachusetts 02021		X		
Pittsburgh Corning Corporation Department TR800 Presque Isle Drive Pittsburgh, Pennsylvania 15239		X		
Plasti-Flo, Incorporated 2701 North Pulaski Chicago, Illinois 60639				
Plastic Applicators Post Office Box 7631-TR Houston, Texas 77007		X	X	
Plastic Machinery Corporation 201 North Border Post Office Box 217 Cleburne, Texas 76031				
Plastic and Metal Products Corporation 1452 County Line Road Huntingdon Valley, Pennsylvania 19006				
Plastic Mold and Engineering Company 261 Wampanoag Trail East Providence, Rhode Island 02915				
Plastic Piping Systems, Incorporated Post Office Box 269-T South Plainfield, New Jersey 07080				
Plastics, Incorporated 500 West Florida Street Milwaukee, Wisconsin 53204				

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Plastiflex Company  
1237-39 Arbor Vitae Street  
Inglewood, California 90301

Plastiline, Incorporated  
1251 Northeast 48 Street  
Post Office Box A  
Pompano Beach, Florida 33061

Plastinetics, Incorporated  
15-T Industrial Road  
Fairfield, New Jersey 07006

Plexco Division  
Post Office Box 10725  
Knoxville, Tennessee 37919

Pluess-Staufner (North American), Incorporated  
(Protexulate)  
One World Trade Center, Suite 2173  
New York, New York 10048

Poling and Bacon Construction Company, Incorporated  
10400 South Avenue  
Youngstown, Ohio 44514

Pollock, William B., Company  
99 Andrews Avenue  
Youngstown, Ohio 44503

Polygon Company Division  
Plas/Steel Products, Incorporated  
East Roosevelt Road at Tennessee  
Walkerton, Indiana 46574

Polykote, Incorporated  
12390 Crossburn Avenue  
Cleveland, Ohio 44135

Polymer Corporation  
2140 Fairmont Avenue  
Reading, Pennsylvania 19603

Porous Concrete Pipe Company  
1746 Lincoln Highway East  
Lancaster, Pennsylvania 17602

Portco Corporation  
Paper and Plastics Division  
4200 Columbia Way  
Vancouver, Washington 98661

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Posey Iron Works, Incorporated  
South and Prince Streets  
Lancaster, Pennsylvania 17604

Power Piping Company  
831 Beaver Avenue  
Pittsburgh, Pennsylvania 15233

Precision Polymers, Incorporated  
1136 U. S. Highway No. 22  
Mountainside, New Jersey 07092

Precision Thermoplastics Corporation  
3410 Democrat Road  
Memphis, Tennessee 38118

Prince Rubber and Plastics Company, Incorporated  
Station B  
Buffalo, New York 14207

Process Piping, Incorporated  
2267 Lithonia Industrial Boulevard  
Lithonia, Georgia 30058

Progressive Alloys Corporation  
16-18 Court Street  
Brooklyn, New York 11241

Protective Plastics Division  
The Carborundum Company  
Diamond State Industrial Park  
Newark, Delaware 19711

Protecto Plas Company  
Post Office Box 294-T  
Cleveland, Ohio 44139

X

Pultrusions Corporation  
Pultrusions Building  
Aurora, Ohio 44202

X

Pure Stone Company  
Box 297  
Marble Falls, Texas 78654

X

Putnam Stainless Steel Tubes, Incorporated  
822 Fairfield Avenue  
Kenilworth, New Jersey 07033

PVC Fabricators  
4386 East 10 Lane  
Hialeah, Florida 33013

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Pyramid Industries, Incorporated  
1422 Irwin Drive  
Erie, Pennsylvania 16505

Pyramid Plastics, Incorporated  
220 West 5th Street  
Department TR  
Hope, Arkansas 71801

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Quick Plastics  
Wayland Drive at Richard  
Jackson, Michigan 49201

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Rain Jet Corporation 303 South Flower Street Burbank, California 91502				
Ramsey Industries, Incorporated 33 Industrial Parkway Northvale, New Jersey 07647				
Randolph Company 1112 Rosine Street Houston, Texas 77019		X		
Raque Manufacturing, Incorporated 725 Beanblossom Road Louisville, Kentucky 40213				
Raymond Metal Products Company Post Office Box 6696 4425 Northpoint Boulevard Baltimore, Maryland 21219		X		
Rea Plastics, Incorporated Post Office Box 766 Kingsport, Tennessee 37662				
Read Plastics, Incorporated 12335 Wilkins Avenue Rockville, Maryland 20852				
Reading Industries, Incorporated Reading Tube Division 530 Main Street Fort Lee, New Jersey 07024		X		
Reco, Incorporated 7th and Hospital Streets Richmond, Virginia 23219		X		
Red Valve Company, Incorporated 600 Bell Avenue Carnegie, Pennsylvania 15106		X		
Reed Manufacturing Company 1425 West Eighth Street Erie, Pennsylvania 16512				
Reeves Rubber, Incorporated 415 Avenida Pico San Clemente, California 92672				

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Rehau Plastiks, Incorporated 3 North Street Waldwick, New Jersey 07463		X	X	X
Reliance Plastic and Chemical Corporation 109 Kearney Street Patterson, New Jersey 07509				
Ramco Manufacturing Company, Incorporated 205 South 85th East Avenue Post Office Box 15613 Tulsa, Oklahoma 74115		X		
Republic Steel Corporation 1441-T Republic Building Post Office Box 6778 Cleveland, Ohio 44101				
Resistoflex Corporation Roseland, New Jersey 07068				
Reutzel, R. E., Company Post Office Box 527 Fremont, Nebraska 68025				
Ric-Wil, Incorporated 10100 Brecksville Road Brecksville, Ohio 44141		X		
Ridge Plastics Company Box 2205 Jonesboro, Arkansas 72401				
Ridge Rool Company 400 Clark Street Elyria, Ohio 44035				
Rite-Flo Manufacturing Corporation 13020 Southwest 87 Avenue Miami, Florida 33156				
Roberts Pipe Line Construction Box 169 Sulphur Springs, Indiana 47388				
Robintech, Incorporated 1407 Texas Street Fort Worth, Texas 76101				

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used In Concepts</u>
Rochester Equipment Company, Incorporated Post Office Box 6420 Rochester, Minnesota 55901				
Rohm and Haas Independence Mall West Philadelphia, Pennsylvania 19105				
Rotuba Extruders, Incorporated 1401 Park Avenue Linden, New Jersey 07036		X		
Rovang, W. G., and Associates, Incorporated 1943 North Columbia Boulevard Portland, Oregon 97217				
Royal Industries Tetrafluor Division 2051 East Maple Avenue El Segundo, California 90245				
Royston Laboratories, Incorporated 128 First Street Pittsburgh, Pennsylvania 15238		X	X	
Russell and Land, Incorporated 4017 East Elchel Avenue Evansville, Indiana 47711				
Ruth-Berry Company 341 East Brooks Road Post Office Box 9056 Memphis, Tennessee 38109				
Ryerson, Joseph T., and Son, Incorporated Box 8000-A Chicago, Illinois 60680		X	X	X



	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Sacramento Pipe Works 116 North 16th Sacramento, California 95803				
Safety Gas Main Stopper Company, Incorporated 525 Atlantic Avenue Brooklyn, New York 11217				
Sage Pipeline, Incorporated Post Office Box 317 Gold Hill, Oregon 97525				
Sandia Laboratories Albuquerque, New Mexico 87115		X	X	X
Sandusky Foundry and Machine Company Fulton and Market Streets Sandusky, Ohio 44870				
Santa Fe - Curran and Company Post Office Box 607 Aurora, Colorado 80010				
Satterlund Supply Company 17300 TR Conant Avenue Detroit, Michigan 48212				
Sawhill Tubular Division Cyclops Corporation Box 11 Sharon, Pennsylvania 16146				
Schnitzer Alloy Products Company 173 Pine Street Elizabeth, New Jersey 07206				
Schulman, A., Incorporated 3550 West Market Street Akron, Ohio 44313				
Schwartz, H., and Sons, Incorporated 5101 Unruh Street Philadelphia, Pennsylvania 13135				
Sciaky Brothers, Incorporated 4915 West 67th Street Chicago, Illinois 60638		X	X	X
Screens and Fabricated Metals Corporation Post Office Box 31 North Bergen, New Jersey 07047				
Sebring Industrial Corporation Post Office Box 467 Sebring, Florida 33870				

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used Concepts</u>
Sellers Company, Incorporated 396 Church Road King of Prussia, Pennsylvania 19406				
SGL Piping Systems Department DS Post Office Box 2747 Wilmington, Delaware 19805		X		
Shamrock Industries, Incorporated Sperzel Building Products Division 1010 Lynoale Avenue, North Minneapolis, Minnesota 55411				
Sharon Steel Corporation Post Office Box 291 Sharon, Pennsylvania 16146				
Sheehan Pipe Line Construction Company 511 National Bank of Tulsa Building Tulsa, Oklahoma 74103				
Sheldon, M. L., Plastics Corporation 350 Lexington Avenue New York, New York 10016		X	X	
Shivel, Incorporated 411 Professional Building Bartlesville, Oklahoma 74003				
Slegfried Insurance 5565 South Lewis Tulsa, Oklahoma 74105				
Silverline Plastics Post Office Box 1806 Asheville, North Carolina 28802				
Simpson Extruded Plastics 4421 Nugget Way Post Office Box 10049 Eugene, Oregon 97403				
Simpson Timber Company Tank and Pipe Division 2301 North Columbia Boulevard Portland, Oregon 27217				
Sloane, R & G, Manufacturing Company, Incorporated 21031 Ventura Boulevard Post Office Box 2300 Woodland Hills, California 91364		X	X	X

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Slocumb Plastic Pipe and Products, Incorporated Drawer J - 302 Esto Highway Slocumb, Alabama 36325				
Smith, David, Steel Company, Incorporated 401 Metuchen Road South Plainfield, New Jersey 07080		X		
Smith, Enoch, Sons Company 1441 Beck Street Salt Lake City, Utah 84116				
Smyth Rubber and Packing Company 512-514 Mercer Street Jersey City, New Jersey 07306				
Snelson, Incorporated Post Office Box 312 Sedro Woolley, Washington 98284				
Soltex Polymer Corporation, a Subsidiary of Solvay and Cie S. A. (Belgium) 550 Broad Street Newark, New Jersey 07102		X	X	
Sommerville-Illinois Company Post Office Box 3158 Peoria, Illinois 61614				
Sometco Plastics Company 3950 Swinnea Road Memphis, Tennessee 38118				
South Dakota Concrete Products Company 222 East Capitol Pierre, South Dakota 57501				
Souther, Incorporated 1952 Kienlen Avenue St. Louis, Missouri 63133		X		
Southern Boiler and Tank Works, Incorporated Thomas and Beltline R.R. Memphis, Tennessee 38107				
Southern Plastic Company Dunbar Road Columbia, South Carolina 29209		X		

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Southwest Fabricating and Weldings Company, Incorporated 7525 Sherman Houston, Texas 77011		X		
Southwest Manufacturing Company Post Office Box 722 Downey, California 90241		X		
Spatz Fiberglass Products, Incorporated Post Office Box 70A Yorklyn, Delaware 19736				
Spear and Wood Manufacturing Company South Wood Street West Memphis, Arkansas 72301				
Speciality Pipe and Tube, Incorporated 302 Martin L. King Avenue Warren, Ohio 44485		X		
Speedline Fittings Division Horace T. Potts Company 538 East Erie Avenue Philadelphia, Pennsylvania 19134		X		
Speicher Brothers, Incorporated 308 Portland Street Celina, Ohio 45882		X		
Spencer, G. R., Construction Company 1605 East Lincoln Fort Collins, Colorado 80521				
Spiratex Company 23403 Kean Avenue Dearborn, Michigan 48124				
SSP Fittings Corporation 108 Northfield Road Bedford, Ohio 44146		X		
Stacey Manufacturing Company 359 Township Avenue Cincinnati, Ohio 45216				
Stainless Tubing and Pipe, Incorporated 1613 Manning Boulevard Bristol, Pennsylvania 19007		X		
Standard Pipe and Supply Company, Incorporated 301 City Line Avenue Bala Cynwyd, Pennsylvania 19004				
Standard Pipeprotection Division General Steel Industries, Incorporated 3000 South Brentwood Boulevard St. Louis, Missouri 63144				

<u>Returned By USFS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
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Standard Plastics  
1760 West 1900 South  
Salt Lake City, Utah 84104

Stanley Supply, Incorporated  
Post Office Box 192  
"B" Street and Hawaiian Avenue  
Wilmington, California 90744

State Pipe and Supply Company  
4442 North Union Boulevard  
St. Louis, Missouri 63115

Stauffer Chemical Corporation  
Post Office Box 1110  
Long Beach, California 90801

Sterns, D. E., Company  
Post Office Box 1234  
Shreveport, Louisiana 71163

S-T-M Supply Company, Incorporated  
97 New Brunswick Avenue  
Hopelawn, New Jersey 08861

Strahs Aluminum Company, Incorporated  
804 Snediker Avenue  
Brooklyn, New York 11207

Structural Fiberglass, Incorporated  
250 Sixth Street  
Verplanck, New York 10596

Stuart Corporation  
1407 South Second Street  
Plainfield, New Jersey 07063

Stupp Corporation  
Post Office Box 3558  
Baton Rouge, Louisiana 70821

Sullair Corporation  
3700 East Michigan Boulevard  
Michigan City, Indiana 45360

Superior Equipment Company  
Post Office Box 769  
Bucyrus, Ohio 44820

Swanson Company  
3747 West Buckeye Road  
Post Office Box 6557  
Phoenix, Arizona 85009

<u>Returned</u> <u>By USPS</u>	<u>Reply</u> <u>Received</u>	<u>Useful</u> <u>Information</u>	<u>Used</u> <u>Concept</u>
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Synthetic Products Company  
Division of Dart Industries  
1636 Wayside Road  
Cleveland, Ohio 44112

S & Z Construction Company, Incorporated  
16875 West Cleveland Avenue  
New Berlin, Wisconsin 53151

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Talent Engineering, Incorporated 680-2 Meyers Street Los Angeles, California 90033		X		
Tapco International, Incorporated 1403 North Post Oak Lane Houston, Texas 77024		X		
Tapecoat Company Division TC Manufacturing Company, Incorporated 1527 Lyons Street Post Office Box 631 Evanston, Illinois 60204		X	X	
Tarnow Pipeline Construction Company, Incorporated Post Office Box 247 Casey, Illinois 62420				
Technical Specialties Company, Incorporated Roslyn Place Mount Vernon, New York 10550				
Telsco Industries Post Office Box 18205 Dallas, Texas 75218				
Tenneco Chemicals, Incorporated Organics and Polymers Division Turner Place, Post Office Box 2 Piscataway, New Jersey 08854		X		
Tennessee Tube Bending, Incorporated Mill Street LaFollete, Tennessee 37766		X		
Tex-Tube Division Detroit Steel Corporation 1503 North Post Oak Road Post Office Box 7705 Houston, Texas 77007				
Thaxton Tool Company Post Office Box 4059-A Pittsburgh, Pennsylvania 15201		X		
Thermacon Industries, Incorporated No. 1 Thermacon Building Rockhill Road Cherry Hill, New Jersey 08034				
Thermoplastics, Incorporated 1401 South Industrial Drive Mishawaka, Indiana 46544				

<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used Conce</u>
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Thompson Culvert Company, Incorporated  
110 Ford Lane  
Hazelwood, Missouri 63042

Thompson Pipe and Steel Company  
3041 Larimer  
Denver, Colorado 80201

Thylin Steel Company, Incorporated  
49-55 30th Street  
Long Island City, New York 11101

Tloga Pipe Supply Company, Incorporated  
2400 Wheatshaf Lane  
Post Office Box 5997  
Philadelphia, Pennsylvania 19137

Tiros Plastics Corporation  
540 Tarrytown Road  
White Plains, New York 10607

Tomaro, Nick and Son, Incorporated  
13597 7 Mile Road  
Caledonia, Wisconsin 53108

Toronto Plastics and Machine Company  
9 Hendricks Avenue and Route 30  
Cheshurst, New Jersey 08089

Transpolymer Industries, Incorporated  
100 South Justison  
Post Office Box 1945T  
Wilmington, Delaware 19899

Trelleborg Rubber Company, Incorporated  
30702 Solon Industrial Parkway  
Solon, Ohio 44139

Trent Tube Division  
South Church Street  
East Troy, Wisconsin 53120

Trenton Pipe Nipple Company  
626-628 Brunswick Avenue  
Trenton, New Jersey 08607

X

Triangle Pipe and Tube Company, Incorporated  
Post Office Box 711  
New Brunswick, New Jersey 08903

Tridyn Industries  
Post Office Box 156  
Colfax, North Carolina 27235

X

X



	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Tri-Point Industries Division of Oak Industries Hoosick Falls, New York 12090		X		
Truly Tubular Fitting Corporation Post Office Box 1160 Mount Vernon, New York 10550		X		
Tube Manufacturing Company, Incorporated 89-T Route 206 Somerville, New Jersey 08876				
Tube Turns Division (Chemetron) 222 Cedar Lane Teaneck, New Jersey 07666		X		
Tubeco, Incorporated 121 Varick Avenue Brooklyn, New York 11237				
Tube-Line Manufacturing Company Division of Midwood Industries, Incorporated 48-13 20th Avenue Long Island City, New York 11105		X		
Tubular Steel, Incorporated Post Office Box 65-T Hazelwood, Missouri 63042				
Tyler Pipe Industries, Incorporated Post Office Box 2027 Tyler, Texas 75701		X		X

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concept</u>
U - Brand Corporation Clark and Greene Streets Ashland, Ohio 44805		X		
Umstead Manufacturing Company 400 East Water Street St. Charles, Michigan 48655				
Unaflex Rubber Corporation 255-T 19th Street Brooklyn, New York 11215	X			
Union Carbide Linde Division 270 Park Avenue New York, New York 10017		X	X	
Union Carbide Corporation Plastics Products Division 270 Park Avenue New York, New York 10017		X		
Uniroyal Chemical EMIC Building Spencer Street Naugatuck, Connecticut 06770				
Uniroyal, Incorporated 1230 Avenue of the Americas New York, New York 10020				
United Air Specialists, Incorporated 6665 Creek Road Cincinnati, Ohio 45242		X		
United Conveyor Corporation 300 Wilmet Road Deerfield, Illinois 60015				
United McGill Corporation Post Office Box 820 TR Columbus, Ohio 44116				
United Moulded Products Corporation 2 Yennicoch Avenue Port Washington, New York 11050				
United Pipe Nipple Company, Incorporated 1867 Atlantic Avenue Brooklyn, New York 11233				

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used In Concepts</u>
United Plastics Division of Environmental Equipment, Incorporated 11627 North Houston-Rosslyn Houston, Texas 77038				
United Plastics Machinery 520 Lancaster Street Frazer, Pennsylvania 19355				
United Sheet Metal Division United McGill Corporation 202 East Broadway Westerville, Ohio 43081		X		
United States Aluminum and Steel Highway Products Corporation 8000 Farrow Road Columbia, South Carolina 29203				
United States Extrusions Corporation Crossways Park Drive Woodbury, New York 11797				
United States Steel Corporation 600 Grant Street Pittsburgh, Pennsylvania 15230		X	X	
United States Steel Corporation Supply Division 13535 South Torrence Avenue Chicago, Illinois 60633				
Urethane Rubber Corporation Post Office Box 646 Mount Clemens, Michigan 48043				
Usona Manufacturing Company 3512-T Chouteau Avenue St. Louis, Missouri 63103				
U.S. Pipe and Foundry Company, Incorporated 1000 West 19th Chattanooga, Tennessee 37408				
U.S. Plastics, Incorporated Post Office Box 152 Houston, Mississippi 38851				
U.S. Tube and Foundry Company, Incorporated 485 Wortman Avenue Brooklyn, New York 11208				

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Vacuum Barrier Corporation 5 Barten Lane Woburn, Massachusetts 01801		X		
Valcor Engineering Corporation 665 Carnegie Avenue Kenilworth, New Jersey 07033		X		
Valley Industrial Plastics Incorporated 2000 Beaver Avenue Monaca, Pennsylvania 15061		X	X	
Valley Steel Products Company Post Office Box 503 St. Louis, Missouri 63166		X		
Valmont Industries, Incorporated Valley, Nebraska 68064		X		
Van Beek Industries, Incorporated 82 Progress Street Union, New Jersey 07083				
Van Ess Company 500 West 7 Mile Road Comstock Park, Michigan 49321				
V.A.W. of America, Incorporated U.S. Route 209 Ellenville, New York 12428				
Vermeer Manufacturing Company Post Office Box 200 Pella, Iowa 50219		X		
Vermeer Sales and Service Post Office Box AK - Highway 16 West Salem, Wisconsin 54669				
Vico Vibration and Noise Control, Incorporated 448 West 36th Street New York, New York 10018				
Vinylex Corporation 2636 Byington - Solway Road Knoxville, Tennessee 37921				

Returned  
By USPS

Reply  
Received

Useful  
Information

Used In  
Concepts

Virginia Metal Manufacturing Company, Incorporated  
Post Office Box 2438  
Roanoke, Virginia 24010

Virginia Plastics Company  
Post Office Box 165-T  
Roanoke, Virginia 24002

Vulcan Lead Products Company  
1543 West Pierce Street  
Milwaukee, Wisconsin 53204

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Walker, Cecil I., Machinery Company Post Office Box 2427 Charleston, West Virginia 25329				
Wallingford Steel Company 100 Valley Street Wallingford, Connecticut 06492		X		
Wallace, William, Division 1475 Old County Road Belmont, California 94002		X		
Warner Manufacturing Corporation 267 Watsessing Avenue Bloomfield, New Jersey 07003				
Warren, John V., Incorporated 502 Wouth Street Rensselaer, New York 12144				
Waterman Construction Company, Incorporated Post Office Box 386 Waterman, Illinois 60556				
Waterman Machine and Manufacturing Company 1223 Germantown Avenue Philadelphia, Pennsylvania 19122				
Web Plastics Company, Incorporated East Ottawa Street Richwood, Ohio 43344				
Wells Engineering Company 2922 West Lake Street Chicago, Illinois 60612				
Wesflex Manufacturing Corporation Post Office Box 1009 Richmond, California 94802		X		
Western Plastics Corporation 2330 Port of Tacoma Road Tacoma, Washington 98421		X		
Western Plastics Corporation East 7th Street Road at Prospect Avenue Post Office Box 249 Hastings, Nebraska 68901				
Westfield Sheet Metal Works, Incorporated 48 Monroe Avenue Kenilworth, New Jersey 07033				

	<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concepts</u>
Wheatland Tube Company Independence Square Public Ledger Building Philadelphia, Pennsylvania 19106				
Wheeling Machine Products Company 1947 Krause Street Wheeling, West Virginia 26003				
Wheeling-Pittsburgh Steel Corporation 4 Gateway Center Post Office Box 118 Pittsburgh, Pennsylvania 15230				
Whinery, W. D., Incorporated Post Office Box 11062-T Tacoma, Washington 98411				
White Metal Rolling and Stamping Corporation 84 Moultrie Street Brooklyn, New York 11222				
Whittaker Pipeline Constructors 7021 Highway 136 Porter, Texas 77365	X			
Wilson-Tek Corporation 900 East National Avenue Brazil, Indiana 47834		X	X	
Witco Chemical Corporation 291 Fairfield Avenue Fairfield, New Jersey 07006				
Woodhill Nipple and Supply, Incorporated East 123rd and Euclid Cleveland, Ohio 44106				
Work Equipment Company, Incorporated 11905 West Ripley Street Milwaukee, Wisconsin 53226		X		
Worthy Brothers Pipeline Corporation 118 Middleboro Road Post Office Box 3009 Wilmington, Delaware 19804				

<u>Returned By USPS</u>	<u>Reply Received</u>	<u>Useful Information</u>	<u>Used in Concept</u>
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Xaloy, Incorporated  
3 Terminal Road  
New Brunswick, New Jersey 08903

X

Yoder Company  
5528 Walworth Avenue  
Cleveland, Ohio 44102

Young Metal Products, Incorporated  
1011 East 148th  
East Chicago, Indiana 46312

X

Youngstown Sheet and Tube Company  
Post Office Box 900  
Youngstown, Ohio 44401

Youngstown Steel and Alloy Company  
Box 217  
520 West Main  
Canfield, Ohio 44406

Youngstown Welding and Engineering Company  
3720 Oakwood Avenue  
Youngstown, Ohio 44509

Zeus Industrial Products, Incorporated  
100 Foot of Thompson Street  
Department TR  
Raritan, New Jersey 08869

X

Zeston, Incorporated  
Post Office Box 46-A  
Fords, New Jersey 08863



APPENDIX D

Other Information Sources

	<u>Reply Received</u>	<u>Useful Information</u>
American Concrete Pipe Association 1501 Wilson Blvd. Arlington, VA 22209	X	X
American Petroleum Institute 2101 L St., N. W. Washington, DC 20034	X	X
American Pipe Fittings Association 26 Sixth St. Stamford, CT 06905	X	X
American Supply Association 221 N. LaSalle St. Chicago, IL 60601	X	
American Welding Society, Inc. 2501 N. W. 7th Street Miami, FL 33125		
Association of Industry Manufacturers 1413 K Street N. W. Washington, DC 20005		
Association of Oil Pipe Lines 1725 K St. N. W. Washington, DC 20006	X	
Bituminous Pipe Institute 111 E. Wacker Dr. Chicago, IL 60601	X	X
Cast Iron Pipe Research Association 1301 W. 22nd St. Suite 323 Oakbrook, IL 60521	X	X
Cast Iron Soil Pipe Institute 2079 K St. N. W. Washington, DC 20006	X	
Concrete Joint Institute 2 Kimball St. Elgin, IL 60120		
Distribution Contractors Association 506 Harvard Tower Tulsa, OK 74135	X	X

	<u>Reply Received</u>	<u>Useful Information</u>
National Association of Pipe Coating Applicators 2504 Flournoy-Lucas Rd. Shreveport, LA 71108	X	X
National Association of Pipe Nipple Manufacturers, Inc. 1745 Merrick Ave. Merrick, NY 11566		
National Certified Pipe Welding Bureau 5530 Wisconsin Ave. Suite 750 Washington, DC 20015	X	X
National Clay Pipe Institute 1130 17th St. N.W. Washington, DC 20015	X	X
National Corrugated Steel Pipe Association Chicago-O'Hare Aerospace Center 4825 N. Scott St. Skinner Park, IL 60176	X	X
National Plumbing, Heating, Cooling and Piping Manufacturers Association 1413 K. St. N. W. Washington, DC 20005		
Pipe Fabrication Institute 1326 Freeport Rd. Pittsburgh, PA 15238	X	X
Pipeline Contractors Association 2800 Republic National Bank Bldg. Dallas, TX 75201		
Piping Promotion Trust 742 Ponce De Leon Place N. E. Atlanta, GA 30306		
Plastics Pipe Institute 250 Park Ave. New York, NY 10017	X	X
Society of Plastics Engineers, Inc. 656 West Putnam Avenue Greenwich, CT 06830		

APPENDIX E  
Concept Comparison Worksheets  
(For Figure 8)

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bands vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method																											
Material	5							8						6	8			10				8	7	5	6	5	
Working Pressure								8												8							
Weight		4	3	3	4															8						6	4

Concept 11112 vs Concept 12342

Concept 11112

Total Score 161

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station
Joining Method					8	9	10	10	8	8	8	9	8	8	8	7	9
Material	5							8				8	8	6	6	6	<del>9</del>
Working Pressure								8								5	<del>7</del>
Weight		4	3	3	4		5									5	<del>7</del>
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## E4

Concept 12343

Total Score 207

Concept / 2343 vs Concept 21111

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT		DEPENDENT																												
Joining Method	Material	Working Pressure	Weight	Storage Life	Air Transport	Manhandling	Equipment Read (ET)	Size of Crews	Skill Level	Equipment Read (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
			4	3	3	4																								
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Concept 12343 vs Concept 21111  
 Concept 21111  
 Total Score 193



[illegible]

Concept 21122 vs Concept 21235

Concept 21122  
Total Score 242

## E7

**INDEPENDENT**

## Joining Method

## Material

## Working Pressure

**Weight**

DEPENDENT

## Storage Life

Air Transport

Manhanding

Equipment Rqd (ET)

## Size of Crews

SKILL Level

Equipment Regd (EI)

## Surface vs Buried

Time per joint

Joint Cleanliness

Manhanding

## Reuse Components

Pre-Fab Capabilities

Bonds vs Fittings

Right of Way Reqd

Inspection/Test

No of Pump Station

Reliability

NY 100-108124-104

Service Life

No Parallel Lines

Product Contam

Working Pressure

**Fraction Factor**

44510M

DIAMETER

Wall Thickness

MATL NOT SUITABLE

Concept 21122 vs Concept 2123C

Concept 2123C

**Total Score** 0

CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method																												
Material																												
Working Pressure																												
Weight																												

MATL NOT SUITABLE

Concept 2173D vs Concept 220DB

Concept 2173D

Total Score 0

Concept 22272 vs Concept 22273

Concept 22272

**Total Score 218**

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT		DEPENDENT																											
Joining Method	Material	Working Pressure	Weight	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
				4	3	3	4		5	8	10	10	8	8	9	8	8	7	6		10	9			8	X	5	6	5
				4	3	3	4			8				8	8	6	6	5	X	7	8	6					6	4	

Concept 22272 vs Concept 22273

Concept 22273

Total Score 220

CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method						8	9	10		<del>10</del>	8	8	8	8	8	8	7	10	9					8	7	5	6	5
Material		5							8				8		6		6	<del>7</del>	7	7	8	6		8	7	5	6	5
Working Pressure									8								<del>7</del>	7	7	8	6					6	4	
Weight			4	3	3	4		5																				

Concept 22341 vs Concept 22356

Concept 22341

Total Score 227



CONCEPT COMPARISON WORKSHEET

INDEPENDENT		DEPENDENT																												
Joining Method	Material	Working Pressure	Weight	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
				✓				8	9	10	8	10	8	8	8	8	6	8	8	7	10	9	6		8	7	5	6	5	
											8						6		5	7	7	8	6	9				6	4	

Concept 22363 vs Concept 22401

Concept 22363

Total Score 229



Concept 22363 vs Concept 22401

Concept 22401

**Total Score** 224

CONCEPT COMPARISON WORKSHEET

INDEPENDENT		DEPENDENT																												
Joining Method	Material	Working Pressure	Weight	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
				X				8	9	10	8	10	8	8	8	9	8	6	8	7	X	9				8	7	5	6	5
										8	8						6	6	5	7	7	8	6	8	7	5	6	6	4	

Concept 22404 vs Concept 225AB

Concept 22404

Total Score 220

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT		DEPENDENT																													
Joining Method	Material	Working Pressure	Weight	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness	
																				</											

Concept 224-04 vs Concept 225AB

Concept 225AB

Total Score 213

CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bands vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method																												
Material		5				8	9	10	8	8	8	8	8	8	6	8	6	7	10	9								
Working Pressure									8				8															
Weight			4	3	3	4		5									5	7	7		8	6				6	4	

Concept 225F1 vs Concept 2269A

Concept 225F1  
Total Score 242

CONCEPT COMPARISON WORKSHEET

INDEPENDENT		DEPENDENT																												
Joining Method	Material	Working Pressure	Weight	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness	
							8	9	10	8	8	8	8	8	8	8	8	8	7	10	9				8	7	5	6	6	5
										8	8					8		6	5	7	8	9			8	7	6	6	4	

Concept 225F1 vs Concept 2269A

Concept 2269A

Total Score 212

[illegible]

Concept 227A6 vs Concept 227C5

Concept 227CS  
Total Score 204

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT		DEPENDENT																											
Joining Method	Material	Working Pressure	Weight	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
	5						8	9	10	8	10	8	8	8	9	8	6	8	7	10	9				8	X	5	6	5
									8	8						6		5	7	7	8	6						6	4
			4	3	3	4		5		8			4																

Concept 228A1 vs Concept 278A2

Concept 228A1

Total Score 235



# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	8	8	8	8	7	10	9									
Material	X						8	8				8	6	6	6	6						X	7	5	6	5	
Working Pressure							8	8								5	7	7		8	6				6	4	
Weight		4	X	3	4		5				X																

Concept 228A1 vs Concept 228A2

Concept 228A2  
Total Score 222

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	9	8	8	8	7	9										
Material	5						8	8			8	8		6		6						8	7	5	6	5	
Working Pressure								8								5	7	7	8	6	6					6	4
Weight		4	3	3	4		5																				

Concept 2294B  
Total Score 232

Concept 2294B vs Concept 232BA

## CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method						8	8	10	8	8	8	8	8	8	6	8	8	8	10	8			8	7	5	6	5	
Material	5						8	10	8	8	8	8	8	8	6	8	6	5	7	7	8	6				6	4	
Working Pressure									8	8																		
Weight			4	3	3	4		5				4																

Concept 2294B vs Concept 232BAConcept 232BATotal Score 190

## CONCEPT COMPARISON WORKSHEET

INDEPENDENT		DEPENDENT																													
Joining Method	Material	Working Pressure	Weight	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness	
			4	3	3	4	5				8	10	8	8	8	8	8	6	8	7	10	9		8	6	8	X	5	X	5	
											8				8		6			6											

Concept 23509 vs Concept 23508Concept 23509Total Score 222

Concept 2350B  
Total Score 242

Concept 23509 vs Concept 2350B

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																											
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness	
Joining Method					8	9	10	10	8	8	8	9	8	8	6	7	10	9					8	7	5	5		5
Material	5							8				8		6		6						8	7	5	5	6	4	6
Working Pressure								8								5	7	7	8	6								
Weight		4	3	3	4	5					4																	

Concept 23709

vs Concept 2370B

Concept 23709

Total Score 236

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	9	8	8	8	7	10	9				8	X	5	6		5
Material	5						8	8				8		6		6										6	4
Working Pressure								8								5	X	7		3	6						
Weight		4	3	3	4		5				4																

Concept 2370B

Total Score 228

Concept 23709 vs Concept 2370B





Concept 240 E2  
Total Score 219

## CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Reqd (ET)	Size of Crews	Skill Level	Equipment Reqd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Reqd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	8	10	8	8	9	8	8	8	7	10	9				8	8	5	5	6	5
Material	5						8	8				8	6	6	5	6						8	8	5	5	6	5
Working Pressure							8	8								5	7	8	6								
Weight		4	3	3	4		5				4																

Concept 24587 vs Concept 24588

Concept 24587

Total Score 222

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT		DEPENDENT																												
Joining Method	Material	Working Pressure	Weight	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
				5				8	9	10	8	10	8	8	8	9	8	6	8	7		9				8	7	5	6	5
											8				8		6			6						8	7	5	6	6
											8									5	7	7	8	6					6	4

Concept 24587 vs Concept 24586

Concept 24588

Total Score 242

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	9	8	8	8	7	10	9									
Material	5						8	8				8	6	6								8	7	5	6	6	5
Working Pressure								8								5	7	7			8						4
Weight		4	3	3	4		5																				

Concept 24589 vs Concept 2458C

Concept 24589  
Total Score 242

MATC NOT SVITABLE

**Total Score** 0

Concept 24789 vs Concept 24761

Concept 24-789  
Total Score 207

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Raise Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	8	<del>10</del>		10	8	8	<del>8</del>	8	6	8	7	10	<del>8</del>				8	7	5	6	5	5
Material	5						<del>8</del>	8				<del>8</del>		6		6										6	4
Working Pressure								8								5	7	7		8	6						
Weight		4	<del>3</del>	4	5																						

Concept 24789 vs Concept 24761

Total Score 190

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	8	10	8	8	8	8	8	8	8	6	7	10	8	8								
Material	5						8	8																			
Working Pressure								8																			
Weight†		4	3	3	4	5																					

Concept 247E2 vs Concept 1234E

Concept 247E2  
Total Score 205



# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bonds vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	8	8	8	8	9	8	8	8	7	9	8	8	8	6	8	8	8	6	5	5
Material								8				8	6	6	6	6	5	7	7	8	6	8	8	6	6	4	
Working Pressure								8								5	7	7	7	8	6	8	8	6	6	4	
Weight	4	3	3	4		5		8			4																

Concept 29762 vs Concept 12346  
 Concept 12346  
 Total Score 190

Concept 12302

Total Score 231

Concept 12342 vs Concept 12343

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	8	8	8	8	7	10	9									
Material	5						10	<del>8</del>				8		6		6						8	7	5	6	5	
Working Pressure								8								5	7	7		8	6					6	4
Weight		4	3	3	4		5				4																

Concept 12342 vs Concept 12343

Concept 12343

Total Score 234

## CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method							<del>8</del>		<del>10</del>	<del>8</del>	<del>8</del>	<del>8</del>	8	6	8	7		10	<del>8</del>			8	7	5	6	5	
Material							<del>8</del>	8	<del>10</del>	<del>8</del>	<del>8</del>	<del>8</del>	8	6		6										6	
Working Pressure								8								5	7	7		8	6						
Weight	4	<del>5</del>	3	4	5																						

Concept 21122 vs Concept 220DBConcept 21122  
Total Score 167



## CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	8	9	8	8	6	7	10	9								
Material	X						8	8				8				6	6						X	5	6	6	5
Working Pressure								8									5	7	7	8	6						
Weight		4	3	3	4	5					4																

Concept 22273Total Score 214Concept 22273 vs Concept 22341

**INDEPENDENT**

## CONCEPT COMPARISON WORKSHEET

[illegible]

Concept 22273 vs Concept 22341

Concept 2239-1  
Total Score 225

## CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station
Joining Method					8	9	10	10	8	8	8	9	8	8	8	7	10
Material	5						8	8				8		6		6	9
Working Pressure								8								5	7
Weight		4	3	3	4		5									6	7
																	10
																	9
																	8
																	7
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																	-98
																	-99
																	-100

Concept 22363 vs Concept 22400Concept 22363Total Score 234



**INDEPENDENT!**

## Joining Method

## Material

## Working Pressure

## Weight

DEPENDENT	4	3	3	4	5
Storage Life	5				
Air Transport					
Manhandling					
Equipment Rqd (ET)					
Size of Crews	8	3	10		
Skill Level					
Equipment Rqd (EI)					
Surface vs Buried					
Time per Joint	10				
Joint Cleanliness	8				
Manhandling	8				
Reuse Components	8				
Pre-Fab Capability	8				
Bends vs Fittings	6				
Right of Way Rqd	8				
Inspection/Test	7				
No of Pump Station	10				
Reliability					
Maintainability	6				
Service Life					
No Parallel Lines					
Product Contam	8				
Working Pressure	8				
Friction Factor	5				
Weight	6				
Diameter					
Wall Thickness	5				

Concept 22363 vs Concept 22404

Concept 22404

**Total Score 724**

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bands vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10		10	8	8	9	8	8	8	7	10	9									
Material	5							8			8	8	6	6	6	6				8	6	8	7	5	6	6	4
Working Pressure								8												8	6						
Weight		4	3	3	4		5																				

Concept 225F1 vs Concept 227AB

Concept 225F1

Total Score 232

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10		10	8	8	9	8	8	8	7	10	9									
Material	5							8				8		<del>8</del>		6						8	7	5	6		
Working Pressure								8								5	7			8	6						
Weight		4	3	3	4		5				4															6	4

E49

Concept 225FI vs Concept 227AB

Concept 227AB

Total Score 229

DEPENDENT

[illegible]

Concept 228A1 vs Concept 2294B

Concept 228A1

**Total score** 229

[illegible]

Concept 228A1 vs Concept 2294B

Concept 2294-B  
Total Score 222

## CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Joints vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	8	9	8	8	7	10	9									
Material	5							8				8		6		6						8	7	5	6	6	5
Working Pressure								8								5	7	7		8	6						4
Weight		4	3	3	4		5				4																

Concept 2350B vs Concept 23709Concept 2350BTotal Score 242

## CONCEPT COMPARISON WORKSHEET

INDEPENDENT		DEPENDENT																													
Joining Method	Material	Working Pressure	Weight	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness	
				5			5	4	3	3	4	5	8	8	8	8	6	8	8	7	10	9		8	6	8	5	6	6	4	
										10	8	10	8	8	8	9	8	6	8	6				8	6		X				X

Concept 2350B vs Concept 23709  
 Concept 23709  
 Total Score 219

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8					10	8	8		8	8	8	7	10	X									
Material	5								8				8		6	6	6						8	7	5	6	5	
Working Pressure									8								5	7	7	X		9				6	4	
Weight		4	3	3	4			5				4																

Concept 240E1 vs Concept 2458Q

Concept 240E1

Total Score 197



**Total Score / 24**

INDEPENDENT		DEPENDENT																												
Joining Method	Material	Working Pressure	Weight	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bands vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
				5				8	9	10	8	10	8	8	8	9	8	6	8	7	10	8	8	8	6	8	8	5	6	5
											8				8	8	6	9	5	7	8	8	6	9	8	8	5	6	6	4

Concept 24589

**Total Score** 219

## CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	8	8	8	8	7	10	9									
Material	5						8	8				8	6	6	6	6	5	7	7	8	6	8	7	5	6	6	5
Working Pressure								8								5	7	7	8	6							
Weight	4	3	3	4	5						4																

Concept 24589 vs Concept 24789Concept 24789Total Score 242

## CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bands vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method																		10	X								
Material	5					X	X	8	X	8	X	8	8	6	8	6	6					8	7	5	6	6	5
Working Pressure								8									5	7	7	8	6						6
Weight		4	3	3	4		5				4																4

Concept 247E2 vs Concept 124-0E

Concept 247E2

Total Score 187

# CONCEPT COMPARISON WORKSHEET

		DEPENDENT																										
INDEPENDENT		Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method						8	9	10	10	8	8	8	8	8	8	8	7	6	10	9				8	X	6	6	5
Material	X								8																			
Working Pressure									8																			
Weight		4	3	3	4		5																					

Concept 2476Z vs Concept 1240E

Concept 1240E

Total Score 210

CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	8	8	8	8	9	8	8	8	7	10	9									
Material								8																			
Working Pressure								8																			
Weight	4	3	3	4																							

Concept 12343 vs Concept 220DB

Concept 1234-3

Total Score 215

CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	8	8	8	8	8	7	10	9									
Material	5								8				8		<del>8</del>		6						8	X	5	6	5	
Working Pressure									8								5	X	7		8	6				6	4	
Weight		4	3	3	4			5																				

Concept 12343 vs Concept 220DB

Concept 220DB

Total Score 228

Concept 22341  
Total Score 232

Concept 2234-1 vs Concept 22343



Concept 22341 vs Concept 22343

Concept 22363

**Total Score** 723

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bands vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	9	8	8	8	7	10	9									
Material	5							8				8		6		6						8	X	5	6	5	
Working Pressure								8								5	X				8	6			6	4	
Weight		4	3	3	4	5					4																

Concept 225FI vs Concept: 228AI

Concept 225FI  
Total Score 228

**INDEPENDENT!**

## Joining Method

## Material

## Working Pressure

Weight

**DEPENDENT**

5

Storage Life

## Air Transport

Manhandlung

Equipment Read (ET)

### Size of Crews

SKILL LEVEL

Equipment Regd (EI)

## Surface vs Buried

Time per joint

Joint cleanliness

Manhanding

## Reuse Components

Pre-Fab Capability

## Bonds vs Fittings

Right of Way Road

Inspection/Test

No of Pump Station

Reliability

Ma!nta!nb!l!ty

Service Life

No Parallel Lines

Product Contam

## Working Pressure

Friction Factor

Wet!

**Diameter**

Wall Thickness

Concept 225F1 vs Concept 228A1

Concept 225A1

**Total Score** 211

[illegible]

Concept 2350B vs Concept 240E1

Concept 2350B

**Total Score 211**

CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																											
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Rouse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness	
Joining Method					8	<del>8</del>	<del>8</del>	8	10	8	8	8	8	8	8	7	10	9										
Material	5							8				8		6		6						8	7	5	6	5		
Working Pressure								8								5	7	7		8	6							
Weight		4	3	3	4		<del>8</del>																				6	4

Concept 2350B vs Concept 240E1

Concept 240E1

Total Score 219

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
Joining Method	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bands vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
	5				8	8	8	8	8	8	8	8	8	8	8	8	7	10	9		8	6	8	7	5	5	5
Material								8				8				6										6	4
Working Pressure			4	3	3	4	5	8								5	7	7	7	8	6						
Weight											4																

Concept 24789 vs Concept 1240E  
 Concept 24789  
 Total Score 220

CONCEPT COMPARISON WORKSHEET

INDEPENDENT		DEPENDENT																													
Joining Method	Material	Working Pressure	Weight	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bonds vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness	
							8 9 10	8	8	8	8	10	8	8	8	8	8	6	8	7	10	9				8	X	X	6	5	
											8									5	X	7	8	6					6	4	

Concept 24789 vs Concept 124-05

Concept 124-05

Total Score 210

APPENDIX F

Concept Comparison Worksheets

(For Figure 14)



## CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Raise Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method						8	9	10	10	8	8	8	8	8	8	8	7	10	9									
Material	5								8				8				6						8	X	5	6	5	
Working Pressure									8								5	X				8	6			6	4	
Weight		4	3	3	4	5																						

Concept 220DB vs Concept 11112Concept 220DBTotal Score 222

## F3

[illegible]

## DEPENDENT

INDEPENDENT	DEPENDENT									
Joining Method	5	8	9	10	10	8	8	7	10	9
Material	5	8	9	8	8	8	8	6	8	8
Working Pressure	5	8	8	8	8	8	8	5	7	8
Weight	4	3	3	4	5	4	4	5	6	6
	Storage Life	Air Transport	Manhandling	Equipment Rqd (ET)	Size of Crews	Skill Level	Equipment Rqd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness
	Manhandling	Equipment Rqd (ET)	Size of Crews	Skill Level	Equipment Rqd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components
	Pre-Fab Capability	Bends vs Fittings	Right of Way Rqd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam
	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness					

Concept 22341 vs Concept 11112

Concept 22341

**Total Score 228**

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Rqd (ET)	Size of Crews	Skill Level	Equipment Rqd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Rqd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	5	2	8	2	8	8	9	8	8	8	7	10		✓				8	7	5	✓	5
Material								8		8		8		6		6											6
Working Pressure								8																			4
Weight	4	3	3	4			5													8	6						

Concept 22341 vs Concept 11112

Concept 11112

Total Score 180

## CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bands vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	8	9	8	8	7	10	9										
Material	5							8	8	8	8	8	8	6	6	8	6	5	7	8	6	8	5	6	6	5		
Working Pressure					4	3	3	4	5	8																		
Weight																												

Concept 225F1 vs Concept 11112Concept 225F1Total Score 220

INDEPENDENT	Joining Method	Material	Working Pressure
DEPENDENT			
Storage Life	<input checked="" type="checkbox"/>		
Air Transport			
Manhandling			
Equipment Req'd (ET)	8		
Size of Crews	8		
Skill Level	<input checked="" type="checkbox"/>		
Equipment Req'd (EI)	<input checked="" type="checkbox"/>		
Surface vs Buried	<input checked="" type="checkbox"/>	8	8
Time per Joint	<input checked="" type="checkbox"/>		
Joint Cleanliness	8		
Manhandling	8		
Reuse Components	<input checked="" type="checkbox"/>	8	
Pre-Fab Capability	8	6	
Bends vs Fittings	8		
Right of Way Req'd	8	6	
Inspection/Test	8	7	5
No of Pump Station	10		
Reliability			
Maintainability	<input checked="" type="checkbox"/>		
Service Life			8
No Parallel Lines			6
Product Contam		8	7
Working Pressure			5
Friction Factor			<input checked="" type="checkbox"/>
Weight			
Diameter			6
Wall Thickness			5

Concept 225F1 vs Concept 11112

Concept 11112

**Total Score 180**

## CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Read (ET)	Size of Crews	Skill Level	Equipment Read (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method				8	9	10	10	8	8	8	8	8	9	8	8	7	10	9									
Material	5						8	8			8	8	6	6	8	6	5	7	7	8	6	8	7	5	6	5	5
Working Pressure							8	8								5	7	7	8	6	9					6	4
Weight	4	3	3	4	5					4																	

Concept 240EI vs Concept 11112Concept 240EITotal Score 242

## CONCEPT COMPARISON WORKSHEET

INDEPENDENT		DEPENDENT																												
Joining Method	Material	Working Pressure	Weight	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
				X			2	8	X	2	8	10	8	8	8	8	8	6	8	7	10	X				8	7	5	X	5
											8						6												6	4

Concept 11112  
Total Score 199

Concept 240E1 vs Concept 11112



[illegible]

Concept 24789 vs Concept 1112

Concept 24789

**Total Score 222**

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Concept 74789 vs Concept 11112

Concept 1112  
Total Score 183

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	9	8	8	8	7	10	9				8	5	5	6	5	5
Material	5							8				8				6	5	7	8	6			5	5	6	6	4
Working Pressure							5	8			4																
Weight		4	3	3	4		5																				

Concept 220DB vs Concept 12342

Concept 220DB  
Total Score 228

## F13

Concept 220DB vs Concept 1234-2

Concept 12342

**Total Score** 215

## F14

[illegible]

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Read (ET)	Size of Crews	Skill Level	Equipment Read (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Read	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	8	8	8	8	6	7	10	9				8	7	5	<del>8</del>	5
Material	<del>X</del>							8				8		6		6										6	4
Working Pressure								8									5	7	7	8	6						
Weight		4	3	3	4		5																				

Concept 2234-1 vs Concept 1234-2  
 Concept 1234-2  
 Total Score 227

CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Rqd (ET)	Size of Crews	Skill Level	Equipment Rqd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Rqd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	8	8	8	8	7	10	9									
Material	5						8	8						6	6	6						8	X	5	5	6	5
Working Pressure							8	8								5	7	8	6	9						6	4
Weight	4	3	3	4	5						4																

Concept 225FI vs Concept 12302

Concept 225FI

Total Score 220

CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method																												
Material																												
Working Pressure																												
Weight																												

Concept 225FI vs Concept 1234-2

Concept 12342

Total Score 204



## CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Raise Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	X	X		10	8	8	X	8	8	8	6	7	10	X				8	7	5	6	5
Material	5							8				8		6		6											
Working Pressure								8																			
Weight		4	3	3	4		5																				

Concept 24-0E1 vs Concept 12342Concept 24-0E1Total Score 205

F19

INDEPENDENT	Joining Method	Material	Working Pressure	Weight
DEPENDENT				
Storage Life	X			4
Air Transport				4
Manhandling				3
Equipment Req'd (ET)				4
Size of Crews	8			4
Skill Level	9			4
Equipment Req'd (EI)	10			4
Surface vs Buried		8		
Time per Joint	12			
Joint Cleanliness	8			
Manhandling	8			
Reuse Components	9	8		
Pre-Fab Capability	8			
Bends vs Fittings	8	6		
Right of Way Req'd	8			
Inspection/Test	7	6	5	
No of Pump Station	10		X	
Reliability	10		X	
Maintainability	6			8
Service Life				8
No Parallel Lines				6
Product Contam		8		
Working Pressure		X		
Friction Factor		X		
Weight		X		
Diameter				6
Well Thickness				5

Concept 240E! vs Concept 12342

Concept 12342

**Total Score 173**

Concept 24789  
Total Score 222

F20

[illegible]

Concept 24789 vs Concept 12342

Concept 24789

**Total Score 222**

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method				8	9	8	8	8	8	8	8	8	8	8	8	8	7	10	9				8	7	5	8	5
Material								8				8		6	8	6						8	7	5	8	5	5
Working Pressure								8								5	7	7		8	6					6	4
Weight	4	3	3	4	5																						

Concept 20789 vs Concept 12342

Concept 12342

Total Score 199

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	9	8	8	8	7	6	10	9				8	7	5	6	5
Material	5							8				8										8	7	5	6	6	4
Working Pressure								8												8	6		7	5	6	6	4
Weight		4	3	3	4		5				4																

Concept 220DB vs Concept 1234-3

Concept 220DB  
Total Score 228

**Total Score 215**

Concept 2234-1 vs Concept 12343

Concept 22341

**Total Score** 242



CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																									
Joining Method																										
Material																										
Working Pressure																										
Weight																										

Concept 12343  
Total Score 223

Concept 22341 vs Concept 12343

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	8	9	8	8	6	7	10	9									
Material	5								8				8		8		6						8	X	5	6	5	
Working Pressure									8								5	X				8				6	4	
Weight			4	3	3	4		5																				

Concept 225 F1 vs Concept 12343  
 Concept 225 F1  
 Total Score 228

INDEPENDENT		DEPENDENT																													
Joining Method	Material	Working Pressure	Weight	Storage Life	Air Transport	Manhandling	Equipment Rqd (ET)	Size of Crews	Skill Level	Equipment Rqd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Rqd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness	
4	3	3	4					8	9		8		8	8	8	8	8	6	8	7	10	9				8	7	5	6		5
											8						6			5			8	6						6	4

Concept 225FI vs Concept 12343

Concept 12343  
Total Score 208

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bands vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	8	10	8	8	8	8	8	8	8	6	8	7	10	8	8	8	8	7	5	6	5	5
Material	5					8	8	8	8	8	8	8	8	6	6	6	5	7	7	8	6	8	7	5	6	6	4
Working Pressure							8	8																			
Weight		4	3	3	4		5				4																

Concept 24061  
Total Score 205

Concept 24061 vs Concept 12343

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method								8 9 10	8	10	8	8	8	8	8	8	6	5	2	9			8	2	5	2	6	5
Material									8				8	8	6		6	5	2	7		8		2	5	2	6	5
Working Pressure									8										2									
Weight												4																

Concept 12343  
Total Score 180

Concept 24061 vs Concept 12343

## CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	9	8	8	8	7	10	9									
Material	5						8	8				8				6						8	X	5	6	5	
Working Pressure								8								5	X									6	4
Weight		4	3	3	4		5				4																

Concept 24789 vs Concept 12343  
 Concept 24789  
 Total Score 222

## F31

**INDEPENDENT**

## Joining Method

## Material

## Working Pressure

Weight

DEPENDENT

Storage Life

## Air Transport

Manhanding

Equipment Req'd (ET)

## Size of Crews

1007 11145

Equipment Read (E1)

## Surface vs Buried

Time per joint

Joint Cleanliness

Manhandlung

## Reuse Components

Pre-Fab Capability

## Bonds vs Fittings

## Right of Way Road

Inspection/Test

No of Pump Station

## Reliability

# Main Title

Service Life

No Parallel Lines

**Product Contam**

## Working Pressure

### Friction Factor

4510M

**Diameter**

Wall Thickness

Concept 24789 vs Concept 12343

Concept 12343

**Total Score** 207

**INDEPENDENT**

[illegible]

Concept 220 DB vs Concept 1234E

## Concept 220DB

**Total Score** 223



# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	9	8	8	8	7	6	10	9								
Material												8		6		6						8					5
Working Pressure								8								5	7	7	8	6						6	4
Weight	4	3	3	4			5																				

Concept 210 DB vs Concept 1234E

Concept 1234E

Total Score 207

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEFENDENT	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bands vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	8	8	8	8	8	8	8	8	8	8	7	10	9	6			6	7	5	8	5
Material	5								8	<del>9</del>	8	8	8	8	6								6	8	7	5	8	5
Working Pressure									8													8	6	7	5	8	6	4
Weight	4	3	3	4	5																							

Concept 22341 vs Concept 12345

Concept 22341

Total Score 222

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bands vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	9	8	8	8	7	10	X									
Material	X							8				8	8	6	6	6						8	X	5	6		5
Working Pressure								X								5	X	7		8	6					6	4
Weight	4	X	3	4	5						4																

Concept 22341 vs Concept 12346

Concept 12346  
Total Score 195

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method						8	9	10	8	8	8	8	8	8	8	8	8	7	10	9				8	7	5	6	5
Material	5							8	8				8	6			6							8	7	5	6	5
Working Pressure								8	8								5	7	7	8	6			8	7	5	6	4
Weight			4	3	3	4		5			4																	

Concept 225FI  
Total Score 232

Concept 225FI vs Concept 1234C

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Rqd (ET)	Size of Crews	Skill Level	Equipment Rqd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Rqd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	<del>10</del>	8	10	8	8	9	8	8	8	7	7	10	9				8	<del>7</del>	5	6	5
Material								8				8		6		6										6	
Working Pressure								<del>8</del>						6		5	<del>7</del>	7		8	6						
Weight		4	3	3	4		5																				

Concept 225F1 vs Concept 1234E

Concept 1234E  
Total Score 205

Concept 240€ vs Concept 1234€

Concept 24061

**Total Score 208**

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT		DEPENDENT																													
Joining Method	Material	Working Pressure	Weight	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness	
				✓				8	9	10	8	✓	8	8	8	6	8	6	8	7	✓	✓	9			8	✓	✓	6	5	
											8						6			5	✓	7		8	6				6	4	
			4	✓	3	4	5				8																				

Concept 24-0E1 vs Concept 1234E

Concept 1234E

Total Score 183

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Read (ET)	Size of Crews	Skill Level	Equipment Read (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Read	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	8	<del>10</del>	8	8	9	8	8	8	7	6		10	9		8	7	5	<del>8</del>	5	
Material	5							8				8														6	4
Working Pressure							5	8								5	7	7		8	6						
Weight		4	3	3	4		5				4																

Concept 24789 vs Concept 1234E  
 Concept 24789  
 Total Score 220



## F41

INDEPENDENT	Joining Method	Material	Working Pressure	Weight
Storage Life		X		4
Air Transport			X	4
Manhandling			X	3
Equipment Req'd (ET)				4
Size of Crews	8			4
Skill Level	9			5
Equipment Req'd (EI)	10			
Surface vs Buried		X	8	
Time per Joint	10			
Joint Cleanliness	8			
Manhandling	8			
Reuse Components	9	8		
Pre-Fab Capability	8			
Bands vs Fittings	8	6		
Right of Way Req'd	7		5	
Inspection/Test	10		X	8
No of Pump Station			7	8
Reliability				6
Maintainability	X			6
Service Life				6
No Parallel Lines		8		
Product Contam		X		
Working Pressure		X		
Friction Factor				6
Weight				5
Diameter				6
Wall Thickness				4

Concept 24-789 vs Concept 1234E

Concept 1234E  
Total Score 194

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Reqd (ET)	Size of Crews	Skill Level	Equipment Reqd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Reqd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	8	8	8	8	8	8	8	6	7	10	9				8	7	5	6	5	
Material	5						8	8	8	8	8	8	8	6	6	6	5	7	7	8	6				6	4	
Working Pressure								8	8																		
Weight		4	3	3	4		5				4																

Concept 220DB vs Concept 1240E  
 Concept 220DB  
 Total Score 232

CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bands vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	9	8	8	8	7	10	9									
Material	X							X				8	6	6	6	6						8	X	X	X	5	5
Working Pressure								8								5	7	7		8	6					6	4
Weight		4	3	3	4		5																				

Concept 220 DB vs Concept 12400F

Concept 12400F  
Total Score 207

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bands vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	8	8	8	8	9	8	8	6	7	10	9				8	7	5	6	6	5
Material	5							8			8			6		6											
Working Pressure								8								5	7	7			8	6					
Weight		4	3	3	4																						

Concept 2234-1

Total Score 223

Concept 2234-1 vs Concept 1240E

**INDEPENDENT**

## Joining Method

## Material

## Working Pressure

Weight

DEPENDENT

Storage Life

Air Transport

Manhandling

Equipment Rqd (ET)

## Size of Crews

SK III Level

Equipment Rqd (E1)

## Surface vs Buried

Time per joint

Joint Cleanliness

Manhanding

## Reuse Components

Pre-Fab Capability

## Bonds vs Fittings

Right of Way Road

Inspection/Test

No of Pump Station

## Reliability

Ma!nta!nab!l!ty

Service Life

No Parallel Lines

**Product Contam**

## Working Pressure

### Friction Factor

Weight

**Director**

Wall Thickness

Concept 22341 vs Concept 12401E

Concept 1240E  
Total Score 215

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bands vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	9	8	8	8	7	10	9									
Material	5						8	8				8		6		6						8	7	5	6	6	5
Working Pressure								8								5	7	7		8	6						4
Weight		4	3	3	4		5				4																

Concept 225F1 vs Concept 1290E  
 Concept 225F1  
 Total Score 242

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method					8	9	10	10	8	8	8	8	8	8	8	7	10	9									
Material	X							8				8		6		6						8			5	6	5
Working Pressure								8								5	X		7	8	6					6	4
Weight		4	3	3	4		5				4																

Concept 225F1 vs Concept 1240E

Concept 1240E

Total Score 215

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bands vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
5					8	✓	8		10	8	8	✓	8	9	8	7		10	9		8	7	5	6	5	6	4

Concept 24061  
Total Score 210

Concept 24061 vs Concept 12406



Concept 24-0E1 vs Concept 12-02E

Concept 124.1E  
Total Score 200

CONCEPT COMPARISON WORKSHEET

		DEPENDENT																										
INDEPENDENT		Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Rause Components	Pre-Fab Capability	Bends vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method						8	9	10	8	10	8	8	9	8	8	8	8	7	10	9				8	7	5	2	5
Material	5								8				8				6						8				6	4
Working Pressure									8								5	7	7	8	6							
Weight		4	3	3	4		5					4																

Concept 24789  
Total Score 220

Concept 24789 vs Concept 1240E

# CONCEPT COMPARISON WORKSHEET

INDEPENDENT	DEPENDENT																										
	Storage Life	Air Transport	Manhandling	Equipment Req'd (ET)	Size of Crews	Skill Level	Equipment Req'd (EI)	Surface vs Buried	Time per Joint	Joint Cleanliness	Manhandling	Reuse Components	Pre-Fab Capability	Bands vs Fittings	Right of Way Req'd	Inspection/Test	No of Pump Station	Reliability	Maintainability	Service Life	No Parallel Lines	Product Contam	Working Pressure	Friction Factor	Weight	Diameter	Wall Thickness
Joining Method							8 9 10	10	8 8 8		8	9 8	8	6	8	7	10	9					8	7	6	5	
Material												8		6									8	7	6	4	
Working Pressure								8			4																
Weight		4	3	3	4		5																				

Concept 124-06

Total Score 210

Concept 24789 vs Concept 12406